

BIOLOGIA

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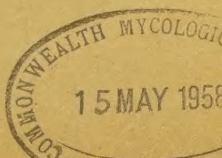
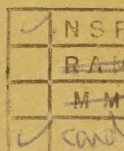
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The Ferns and Fern Allies of West Pakistan and Kashmir

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INTRODUCTION

The plains of West Pakistan are too dry for ferns and even in the foothills few are to be found. Below two thousand feet less than ten can be expected and these only in favourable places like Lahore where there is a good deal of irrigation. In such places *Adiantum capillus veneris*, *Goniopteris prolifera*, *Pteris vittata*, *Ophioglossum aitchisoni*, *Marsilea minuta*, *Azolla pinnata* and *Equisetum debile* are to be found. Only nine ferns are reported from the dry mountains of Waziristan and five from the Salt Range.

Ferns increase in number and importance with the rainfall and the number of species of ferns in a region is a good indication of the amount of rain the area receives. As one travels east into India from the Afghan mountains the rainfall gradually increases. Hope reported 27 ferns from Chitral. There are 42 in the Murree Hills and in a single Hill Station, Pahlgam in Kashmir, I found 52. There are just over 100 in the whole of Kashmir, 130 in Mussoorie and about 450 in Burma. Parts of Kashmir are rich in ferns but they are almost all found on shady rocks, in forest humus, on stream banks or on alpine meadows. There are very few epiphytes and tree trunks are never covered with ferns as they are in the Himalayan Hill Stations east of Kashmir. I have, however, found *Pyrrosia mollis* in Poonch and *Polypodium nudum* in Kotli growing on tree trunks.

Little has been written about the ferns of West Pakistan but almost all are fairly well known and are to be found in the lists of Beddome,

Clarke and Hope, though frequently under names which are no longer used in fern literature. Our knowledge of fern distribution is, however, very meagre as little collecting has been done in many valleys. Some, like the valleys of Swat and Poonch, have only recently become accessible. On the other hand there has been a great deal of collecting in Kashmir for more than a hundred years and large numbers of specimens have been deposited in the great museums of India, Europe and America. Unfortunately we have no national herbarium in Pakistan and the only large fern collection in this country is in Gordon College, Rawalpindi. This collection is largely based on about 2,000 mounted sheets of specimens collected by E.W. Trotter between 1885 and 1890 or obtained by him in exchange. My own collections began in Kashmir in 1912 and they are supplemented by the collections of the staff and students of the college so that all but a very few of those mentioned in this list have been collected by us. The names of most of the critical species have been checked by Mr A.H.G. Alston of the British Museum.

There is unfortunately no recent fern literature which can be put in the hands of an interested visitor or student. The Supplement to Beddome's Handbook is dated 1892 and the Handbook was published in 1883. They are useful but hard to obtain. C.B. Clarke's Review of the Ferns of Northern India was published even earlier in 1880. The most recent and most useful list for the mountains of West Pakistan is that of Hope, published in the Journal of the Bombay Natural History Society from 1899 to 1904. As much collecting has been done in the last fifty years and as ideas on fern classification have changed a good deal in this period an up to date list of these interesting plants is very desirable.

Most of the West Pakistan ferns are to be found in the temperate and alpine regions which have a good monsoon rainfall. The outer foothills are too dry and the inner valleys of Chitral, Gilgit and Baltistan are beyond the reach of the summer rains and are dry except where there is melting snow or running water.

There are 127 ferns in the present list. In checking it through I was surprised to find that only thirty seem to be really common. Quite a few have only been reported once. As far as I can discover, the following have not previously been reported from our area: *Cystopteris dickieana*, *Dryopteris oreades*, *D. chrysocarpa*, *Actinopteris australis*, *Polypodium (Pleopeltis) nudum*, *Pyrrosia mollis*, and *Equisetum palustre*. In 1945 in a catalog of the ferns of Kashmir I listed a few others which had apparently been overlooked by earlier workers.

I am somewhat doubtful about the following four ferns which have been reported from our area. These are *Notholaena vellea*, *N. marantae*, *Dryopteris brunnea* and *D. hexagonoptera*. What has been called *D. brunnea* is probably *Dryopteris late-repens* without a rhizome. These four species should be looked for.

There are a few ferns like *Lygodium scandens* and *Dryopteris ludens* (both collected only once) and *Goniopteris* with tropical affinities and a few others like *Ceterach officinarum*, *Cheilanthes persica* and *C. pteridioides* which are Mediterranean types. Most of our ferns are temperate or alpine and many are European or are found even further afield. None of our ferns appears to be endemic. Their affinities are northern or western rather than eastern or Himalayan. A European or North American botanist would feel more at home with our ferns than would one who knows only the ferns of the Indian Hill Stations like Dharmasala or Mussoorie with a much higher rainfall. It seems to me remarkable that only 17 of the 52 Pahlgam ferns are listed in the 135 known to grow in or near Mussoorie only three hundred miles to the east while 16 are North American. Only eight Pahlgam ferns are listed among the 450 Burmese ferns in Dickason's catalogue.

Dryopteris is much the largest genus. Then in order of importance we find *Athyrium*, *Asplenium*, *Polystichum*, *Cheilanthes*, *Polypodium*, *Adiantum*, *Equisetum*, *Selaginella* and *Pteris*. The other genera represented have less than four species each.

Possibly because fern spores are so easily carried long distances by the wind a species may turn up hundreds of miles away from its nearest known habitat. A persistent collector is often rewarded for his exertions by finding rarities. In 1956 I found a colony of *Dryopteris chrysocoma* near Thandiani in Hazara far to the west of any previously known station and this year *Actinopteris* was found in Attock Dist. A few years ago we found the Mouse Ear Fern (*Gymnopteris vestita*) in Swat and *Pellaea hastata* in Abbottabad. The presence of *Dryopteris oreades*, a Caucasus fern, in Swat and Gilgit was another pleasant surprise as was the discovery by Gen. Gatacre near Ziarat in Chitral of the two tropical ferns *Dryopteris ludens* and *Lygodium scandens*.

Synonymy presents a difficult problem to the pteridologist as there have been "lumpers" who prefer big, inclusive genera like *Dryopteris* and *Polypodium* while the "splitters" prefer smaller units and have divided these big genera into a number of smaller units. At the present time the

tendency is to favour using the smaller genera following the recent work of such men as Ching and Copeland.

A word should be said about collecting. Many specimens in collections cannot be determined with certainty because of the lack of the rhizome with its scales which are often distinctive. It is often necessary to know whether the rhizome was creeping or not. Most students and many of their seniors fail to keep records of collection dates, localities, altitudes and other useful data which should be recorded on a label. Only a few collectors number their gatherings. It is sad to find a good deal of money spent on visiting out of the way places without the collector keeping proper records. Many collectors allow mildew to ruin their collections through failure to change their blotters frequently enough. I have also seen many collections ruined by failure to poison the specimens allowing insects to do irreparable damage. Artificial heat should be used to dry specimens in very wet weather.

It is not likely that future collectors in West Pakistan and Kashmir will discover any fern species which are new to science but the chance of adding more species and new localities is very good and I hope that many will try to make this list more complete.

I am grateful for the help of Mr A.H.G. Alston who has corrected a good many of my identifications and to Mr Eugene Nasir of Gordon College who has accompanied me on many of my trips.

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FERNS

POLYPODIACEAE

Woodsia

1. **W. alpina** (Bolton) Gray ; (*Woodsia hyperborea* of Bedd. p.20) is a rare alpine found occasionally in rock crevices at from 8-14,000' It is simply pinnate and only 3-4" tall with hairs in the sori. Aitchison reported it from the Kurram Vy. I have found it near Bedori in Poonch and near Sonamarg, Mt. Kolahoi and Pahlgam in Kashmir.

Cystopteris

2. **C. fragilis** (L.) Bernh. ; Beddome p.70, is one of the commonest ferns in the Himalayas both in the inner and outer ranges from about 5,500' to the snow line. It is fond of shady places under rocks, is variable in size and usually fruits freely.

3. **C. dickieana** R. Sim in Gard. and Farmers Journ. 308, 1948, is outwardly like the last species and has been overlooked by collectors. The spores are roughened but are not pectinate like those of *C. fragilis*. Mr Alston of the British Museum found it among my Swat specimens and in examining herbarium specimens I find that it also grows in the Kishenganga Vy., Baltistan and on the Rajdani Pass in Kashmir.

C. montana (Lam.) Bernh.; Bedd. Supplement p.15, is a very rare alpine. The fronds are deltoid ovate and 3-4 pinnate suggesting *Dryopteris remotipinnata* of Hayata (*D. linneana* of some authors). Inayat found it at Bungas in Muzaffarabad Dist. in 1897. Aitchison found it in Gulmarg and I found it at Sonamarg in the birch zone in a cliff crevice. The rhizome is creeping.

Dryopteris

As used by Christensen *Dryopteris* is much the largest genus in our area. Others split the group into a number of genera. Many of our commonest ferns belong to this genus.

5. **D. chrysocoma** (Christ) C. Chr.; (*Lastrea filix mas* var. *schimperiana* in Bedd. Suppl. p. 58). Christensen seems to call the species *Dryopteris cochleata* var. *schimperiana* (Clarke) C. Chr. I do not think that it has any connection with *D. cochleata* which is a dimorphic species with the sori covering the entire under surface of the fertile fronds.

This plant seems to be very rare in our region. I found it in two places on Sidandi Hill near Thandiani, Hazara at about 7,500' growing on limestone and in 1888 Trotter found it at Rattanpir, Poonch at 8,000', also on limestone. This fern is common further east.

6. **D. paleacea** (Sw.) C. Chr.; (*D. filix mas* var. *paleacea* C. Chr.; *Aspidium patentissima* Wall.). See Bedd. p. 249. This is the scaliest of the tufted dryopterids with fronds rising like the feathers of a shuttlecock. The scales are dark chestnut or nearly black and very numerous and the under surfaces of the pinnae are copiously clothed with fibrillae. This fern is usually found from Chamba east but I found it once at Fras Nag in Kashmir between 8 and 9,000'.

7. **D. sinofibrillosa** Ching; (*D. fibrillosa* (Clarke) Hand. Maz.; *D. filix mas* var. *fibrillosa* (Clarke) C. Chr.). See Bedd. p. 250. This is a most handsome forest fern which I have been calling *D. rosthornii*. It is a size smaller than the last. The basal scales are shiny and black, the stipes short and the pinnules almost entire. Clarke called it the north-western '*patentissima*', i.e. *paleacea*. It is fairly common from 5-11,000' from Swat to Simla.

8. **D. blanfordii** (Hope) C. Chr.; (*Nephrodium blanfordii* Hope in Jour. Bomb. Nat. Hist. Soc. 12: 624, p. 11. 1899). This fern is not very common but has been collected in a good many places from Swat, Hazara and Baltistan eastward at from 7 to 11,000'. This is another western form with a short stipe with broad, dark basal scales while they are more narrow and acuminate in No. 7. The stipes are pale under the scales, not reddish black as in *D. sinofibrillosa*.

9. **D. oreades** Fomin is a Caucasus fern not heretofore reported from India-Pakistan but was discovered in a packet of puzzling ferns sent to Mr Alston. Two specimens were found in Swat, one in the Sho Nala and the other above Ushu at about 8,000'. I have also found it at Sonamarg and Minimarg in Kashmir, a little above 9,000'. The stipes are pale and short, only 2-3" long, the scales are pale chestnut and numerous at the base; smaller upwards, the fronds taper both ways, the lower pinnae being sterile. The lower pinnae are not at right angles but are pointed upward.

10. **D. odontoloma** (Moore) C. Chr. (*Lastrea filix mas* var. *odontoloma* Hk.). See Bedd. Suppl. p. 55. This is possibly the commonest fern in the forests of the outer hills from 5-10,000'. In some places *D. ramosa* is equally abundant as in the higher 'Galis' of Hazara. The

stipes and fronds dry a pale green colour and have a distinctive bluish green colour when fresh. Because of its colour Bory called the species *Lastrea pallidum*. It is smaller than *D. ramosa* and may grow near it but tends to be able to live in drier places than suit '*ramosa*'. Hope says "Stipe usually long, sori small, pinnae distant, increasingly so downwards, 3-5 lowest pairs of pinnae barren."

11. **D. marginata** (Wall.) Christ; (*Nephrodium filix mas* var. *marginata* Wall. ex Clarke; *Lastrea filix mas* var. *elongata* Hk. and Grev.) has been reported from various places in Pakistan and Kashmir from 5-11,000' but I am inclined to think that true *marginata* grows further east with a rhizome which is more slender, creeps further and bears only one large leaf at a time. I found it abundant in the Mussoorie area and it may get into eastern Kashmir. I refer western forms to *D. ramosa*.

12. **D. ramosa** (Hope) C. Chr.; (*Nephrodium ramosum* Hope, Jour. Bomb. Nat. Hist. Soc. 14 : 739, pl. 32, 1903). This is the largest of the 'male ferns' and it is very common in such places as Changla Gali, Dunga Gali and Thandiani but may be found as low as 4,000' in the Kishenganga Valley and as high as 12,000' near Dras (Duthie). It is thrice pinnate or nearly so and is usually broadest at the base. The rhizome is thick and slowly creeping. The basal scales and stems are pallid as in *D. odontoloma*. It is found usually in damp shady forest among herbage.

13. **D. brunoniana** (Wall.) O. Kze.; (*Lastrea brunoniana* Wall.). See Bedd. p. 246. This is a common alpine fern found in large masses on alpine meadows. The stipe and rachis are dark reddish or almost black. It is often found with *D. barbigera* and *Polystichum prescottianum*. It is usually found from 9 to 13,000' from Swat eastward.

D. barbigera (Moore) O. Kze. ; (*Lastrea barbigera* Hk.) ; Bedd. p. 246. This is another fine, large alpine meadow fern found from the Kurram eastward. This species is broader for its length than the last and much more scaly. The stipe and rachis are pale brown, paler than the scales which are chestnut in colour while in *D. brunonianum* the stipe and rachis are blacker than the scales.

15. **D. barbigera** var. **falconeri** (Hk.) C. Chr.; (*Lastrea falconeri* Hk.). Clarke felt that this form was not different enough for a distinctive name. The fronds are larger, pinnules longer and narrower, rachises more glandular resinous. My specimens from Khillanmarg, above Gulmarg and from the Rajdani Pass seem to belong to this form which may be an ecotype.

16. **D. serrato-dentata** (Bedd.) Hayata; *Lastrea serrato-dentata* Bedd.) See Handb. Suppl. p. 55. This is a rare, high level fern which Inayat found in the Kagan Vy. at 12,200' and Duthie in the Chatponsal Nullah near Baltal in Kashmir. It has also been found in Chamba and Tehri. It is rather small and once pinnate, stipes sometimes as long or longer than the frond; sori rather large, scales at the base large. To be looked for between 10 and 13,000'. A specimen I found on the Burzil Pass may belong here.

17. **D. crenata** (Forsk.) O. Kze.; (*Lastrea crenata* (Forsk.) Bedd. p. 258; *Hypodematum crenatum* (Forsk.) Ching). This is a very fine fern varying greatly in size which always seems to grow in crevices of limestone, sandstone or shale. Fronds are roughly triangular and the bases are covered by a mass of long chestnut coloured scales. It is a sun plant and may be found from 2 to 8,000' in the outer hills from Swat and Hazara east.

18. **D. thelypteris** (L.) A. Gray; (*Lastrea* in Bedd. p. 241); Black Footed Swamp Fern. This plant does not seem to have been found west of Kashmir, and the only place where I have found it abundant is at Nil Nag, 6,800' growing in water and on partly submerged logs. It is found between 5 and 7,000'. It has been found in the Dal Lake near Srinagar and I found it twice at Kangan in the lower Sind Vy. The rootstock creeps freely. "The young stipes and fronds before they develop are very black as is also the lower inch or two of the stipes of fully developed fronds, in striking contrast with the pale yellowish green of the fronds"

19. **D. hirtipes** (Bl.) O. Kze.; (*Lastrea* in Bedd. p. 232 ; *Aspidium atratum* Wall. ; *D. hirtipes* var. *atrata* (Wall.) C. Chr.). This eastern fern is very rare having been only collected once by McDonell in 1891 at Ghantamula, Kashmir at 5,500'. It is a large fern with fronds up to 3 ft. tall. The pinnae are numerous, linear lanceolate from a broad base, 4-8'' long by nearly 1'' broad. The scales of stipe and rachis are mostly very dense, linear, black or blackish, sometimes distinctly fimbriate.

20. **D. brunnea** (Don) C. Chr. ; (*Phegopteris distans* (Don) Bedd., p. 292). Duthie's 23, 236 from Jabari, Siran Range as well as a number of specimens from Chamba, Kulu and other places east of Kashmir have been referred to this species which is supposed to have an erect caudex. When going through the large fern collection at Dehra Dun a few years ago I found that all of the specimens referred to *D. brunnea* were without rhizomes so I suspect that there may not be any true *brunnea* in our area but that these specimens are really the next species in this list, *D. laterepens*.

21. **D. laterepens** (Trotter and Hope) C. Chr. ; (*Polypodium laterepens* Trotter in Hope, Jour. Bomb. Nat. Hist. Soc. 12 : 628, pl. 14, 1899). This is a rather common fern found from Swat eastwards at altitudes of from 5 to 10,000' in damp soil in forest shade. It is a tall fern, rather narrow for its height which is distinguished by a wide spreading underground rootstock with scattered dark coloured stipes bent around at the base. It is fairly common in the Hazara Galis from Changla to Thandiani and it grows at Gulmarg and in Poonch.

22. **D. levingei** (Clarke) C. Chr.; (*Leptogramme aurita* var. *levingei* (Clarke) in Bedd. p.377). Baker and Clarke refer the species to *Gymnogramme*. According to Ching the correct name for the species is *Thelypteris levingei* (Clarke) Ching. Like the last species it is found in marshy soil in forest shade from 4 to 8,000'. It has been collected in a good many places from the Lowari Pass in Chitral eastward. I have found it in Swat, Gilgit, the Kishenganga Vy., the Hazara Galis and in Kashmir. It also has a creeping rhizome but it is a smaller fern with more slender rhizomes, and fewer pinnae but the pinnae are broader for their length than in *laterepens*. The fronds are pilose on both surfaces.

23. **D. repens** (Hope) C. Chr. ; (*Nephrodium repens* Hope, l.c. 12 : 535. 1899; under *Lastrea ochthodes* Kze. in Bedd. p. 240). Clarke gives the distribution of this fern from Kashmir east to Burma but I have no Kashmir specimen though I have one from Dalhousie collected in 1917. It may well grow in the Jammu Hills. It is easily recognized as the lower pinnae are not gradually reduced but are suddenly abortive and reduced to tuberculated glands.

24. **D. rampans** (Baker) C. Chr.; (*Nephrodium costatum* (Wall.) Bedd. p.275; *D. penangiana* (Hk.) C. Chr.). This is a fine, large, once pinnate fern growing near streams and waterfalls with leaves up to 5' long. It is rare having been found at 3,000 in Poonch many years ago by Sage and by me in the Nawal Nadi, Poonch at about 3,500' in 1952. It is not rare further east from 3 to 8,000'. The leaflets resemble those of *D. mouleimensis*. The pinnae are from 5 to 8" long and about 1/2" wide though they may be one inch broad on sterile fronds. The rhizome is creeping.

25. **D. erubescens** (Wall.) C. Chr. ; (*Phegopteris erubescens* Bedd. p. 289.) This is another large semi-tropical fern which is rare east of Chamba. It is usually found at from 3 to 6,000' in wet ground below springs or on the banks of streams. Large fronds may be five or six ft. long. It was found many years ago on the Black Mt., Hazara and I have found it in the lower Kishenganga Vy. and at Gorrah in Poonch at 4,000' The sori are in rows

close to the midrib, the fronds are rather coriaceous, glabrous above, a few long needle like hairs below and the lowest two pairs of pinnae are shorter and deflexed.

26. **D. dentata** (Forsk.) C. Chr. ; (*Polypodium dentatum* Forsk. ; *Nephrodium molle* in Bedd.p.277). This a common low level fern from the plains to 4,500' and from the Kurram eastward. It is found throughout our region in the foothill zone. The fronds are hairy, once pinnate and basal pinnae are reduced.

27. **D. hexagonoptera** (Michx.) C. Chr. ; (*Phegopteris hexagonopterum* Michx. in Bedd. Suppl. p.92). The Broad Beech Fern has only been reported by Watt from Zanskar. This species is close to *D. Phegopteris* but the blades are usually broader than long ; rachis and midveins hardly chaffy, under surfaces slightly pilose.

28. **D. phegopteris** (L) C.Chr.; (*Polypodium phegopteris* L. ; *Phegopteris vulgaris* Mett. in Bedd.p.290). This is not a common fern in our area but it is found in many places clear across the Northern Hemisphere including the U.S.A. Harriss found it at Mirza in Chitral. It has not yet been reported from West Pakistan but Hope gives four Kashmir records. I have found it at Gulmarg, Khillanmarg, Fras Nag and the Rajdani Pass. It is usually found between 9 and 12,000'. The blades are usually longer than broad, rachis and midveins freely chaffy, under surfaces pilose.

29. **D. remotipinnata** Hayata ; (*Phegopteris dryopteris* (L.) Fee in Bedd.p.293) This fern seems to be intermediate between the European *D. limeana* and *D. robertiana* and Himalayan specimens have been referred to both of these species. According to Mr Alston they are neither but a distinct species. It is common between 5 and 10,000' in evergreen forests or protected by rocks. It is called Oak Fern in the West. The fronds are triangular and nearly glabrous. The basal pinnae are not deflexed as they are in *D. phegopteris*. It is found in Swat, Gilgit and Baltistan as well as on the southern slopes of the Himalayas.

Ampelopteris

30. **A. prolifera** (Retz.) Copeland; (*Goniopteris prolifera* (Roxb.) in Bedd. p.296; *Dryopteris prolifera* (Retz.) C. Chr.). This is a tropical or semi-tropical plains plant which grows below 3,000'. It becomes commoner east of Kashmir. I have found it at two places in Haripur tehsil of Hazara Dist. and it should be looked for in Poonch. It is a very vigorous, much branched plant growing in wet soil near irrigation ditches in Hazara. Strong axillary shoots take root and the fern spreads rapidly.

Hypolepis

31. **H. punctata** (Thunb.) Mett. ; (*Dryopteris punctata* (Thunb.) C. Chr. ; *Phegopteris punctata* (Thunb.) Bedd. p.295). This is an eastern fern which has previously been reported from Chamba eastward from about 4 to 6,000'. I have found it only at Ramsu on the Jumu-Kashmir Road at about 4,000' in wet shady soil. Like *Dryopteris laterepens* it has a wide branching rhizome. The rhizome is hairy and rather thin for the size of the fronds. The leaves are coriaceous and have a varnished appearance on the upper surface. The rachises are rough to the touch. The fronds are sometimes quite large. The secondary rachises are not at right angles but come off at an angle less than 90'.

Polystichum

32. **P. lonchitis** (L.) Roth; Beddome, p.203. This is a cosmopolitan high level fern usually found from 9-12,000' and often growing in the birch zone. It was formerly considered to be rare in our area but it was probably overlooked. It has been collected on the Lowari Pass in Chitral, in Swat, Gilgit, Kagan, Poonch, Kamri Pass, Apharwat, Sonamarg etc. Being evergreen it is often called Christmas Fern. It is tufted, coriaceous and the old leaf bases persist. The fronds are once pinnate and the pinnae are entire.

33. **P. lachenense** (Hk.) Bedd. p. 203. This is a coriaceous high level fern usually found in rock crevices above the tree line at from 12-16,000'. The fronds are curved and old leaf bases remain attached for years. The pinnae are blunt and little toothed. It has been reported from Gilgit and I have collected it above Sonamarg, at Harnag near Kolahoi, on the Zojibal Pass, on the Yamhar Pass, Kamri Pass etc.

34. **P. prescottianum** (Wall.) Moore; Bedd. p. 210. This is a very common fern growing in masses on alpine meadows in the open, from the Kurram to Sikkim. It is usually found from 9,500 to 13,000'. It is often found with *Dryopteris brunoniana* and *D. barbigera*. The fronds are much longer than in the last two species and there are usually from 35-40 pairs of pinnae. The scales are very numerous, pale and almost transparent and the secondary rachises are straw coloured. There are hair like scales on both sides of the fronds and hair like tips to the pinnae tips.

35. **P. bakerianum** Diels ; (*P. prescottianum* var. *bakerianum* in Bedd. Suppl. p. 43). Clarke considered this form to be a flaccid variety of No. 34 and Beddome p. 210, calls it *P. prescottianum* var. *bakerianum* Clarke. The stipes are 6'' or more long; blades 18 to 24'' long. 6-10''

broad, middle pinnae longest". The upper surface is practically glabrous, lacking the long white hairs of the last. It has not been collected very often. Clarke found it in the Sind Vy. at 12,000'. Trotter reported it from the Pir Punjal at 11,500'. I collected it at the Gangabal Lakes at about 11,000' and there are a few other scattered records.

36. **P. thomsoni** (Hk.) Bedd. ; Bedd. p. 206. This is small, delicate species, smaller than the four already mentioned, looking like a small edition of *P. prescottianum*. It is hardly common but has been found a good many times in widely scattered places from 6,500' to 12,500'. I have collected it in Swat and in various places in Baltistan and Hazara. It has been collected at Changla Gali, Dunga Gali and Thandiani in Hazara. Beddome states that it differs from small specimens of *P. prescottianum* by having fibrillose, not scaly stipes.

37. **P. discretum** (Don) J. Sm.; (*P. tsus-simense* (Hk.) J. Sm.). See Beddome p. 207 where it is under *P. aculeatum*. This is a plant of the outer ranges between 3,500' and 8,000'. It is the most glabrous of our *Polystichums* and it is not very large. The basal scales are very black. The upper portion of the frond is once pinnate while it is twice pinnate below. The lowest pair of pinnae are deflexed. The plants dry a peculiar glaucous green. It is found in Swat, in the lower Kagan and Kishenganga Valleys and in Poonch. I have also found it on the Jhelum Valley Road.

38. **P. squarrosus** (Don) Fee; (*P. lobatum* var. *squarrosus* C. Chr.; *P. aculeatum* var. *rufobarbatum* Wall. in Bedd. p. 207). This is a large and common, very coriaceous fern which has been called the Red Bearded Christmas Fern. It is much more common east of Kashmir than in our area where it is not nearly as common as the more herbaceous *P. nigropaleaceum* (*P. aculeatum* var. of Indian botanists). The only place where I have found it to be common in Pakistan is at Serimang in Poonch at about 6,000'. It is usually found between 6 and 8,000' but may grow between 3,500 and 9,500'. I have found it in Swat and in Hazara it has been found in the Siran and Kagan Vys. It is able to grow in comparatively dry situations and is covered with reddish scales which give it its name 'Red Bearded'. Less commonly basal scales may be dark brown. Fronds are tougher and thicker than in 39.

39. **P. nigropaleaceum** (Christ) Diels ; (*P. aculeatum* (L.) Schott var.; *P. aculeatum* var. *angulare* auctt.). See Bedd. p. 207. The basal scales are ovate and nearly black, not rufous as in No. 38. This is a common fern in our area from Swat east growing from 4,500' to 10,000' in thin forest shade in the same sort of places as *Adiantum venustum*. The scales on rachis and stipe are hair like.

Cyrtomium

40. **C. caryotideum** (Wall.) Pr. ; (*Polystichum falcatum* ssp. *caryotideum* C. Chr. ; *Cyrtomium falcatum* Sw. var. *caryotideum* Wall.). See Bedd. p. 211. This is a handsome fern which is sometimes cultivated in pots in the plains. It is commoner east of Kashmir but it has been found in a number of scattered localities in our area. It is to be looked for in shady woods near running streams between 3 and 7,000'. It is easily recognized by the broad, falcate pinnae. It has been found in Swat, Hazara, the Kishenganga and Jhelum Vys. and in Poonch. I have only found it to be common near Serimang in Poonch.

Microlepia

41. **M. wilfordii** Moore. This rare fern was first found by Mc Donell in the Buniar Nullah near Rampur on the Jhelum Valley Road. I found it on 6-9-1927 at about 4,000'. near the place it was found thirty years previously on a steep bank wet from water leaking from a water channel. When I found it I took it to be *Leucostegia immersa* but its texture is more herbaceous, the fronds are narrower and the apical sori are smaller.

Athyrium

42. **A. crenatum** (Sommerf.) Rupr. var. **glabratum** Ching. This is a very rare fern and I am not at all sure about it. It has only been reported from our region from the Keran Nullah, Kishenganga Vy. at 8,000' by Mc Donell in Sept. 1891. Hope thinks that *A. crenatum* cannot be separated from *Diplazium squamigerum*. The sori are supposed to be shorter in *A. crenatum*. This should be looked for.

43. **A. acrostichoides** (Sw.) Diels; (*A. thelypteroides* Michx. in Hope) ; Bedd. p. 164. A very large and common fern, tufted, sometimes covering hillsides in forests with its circular tufts which may be three ft. tall. It is also common in gulley bottoms. The lobing of the pinnae is very regular. The scales on the rachis are very pale and hair like turning a little darker on drying. The young stipes are green. It is found from the Kurram eastward at from 7 to 11,000'.

44. **A. mc donelli** Bedd. Handb. Suppl. p. 34. A rare fern first collected by Mc Donell in Chamba at 5,000'. It has been collected at several places in Kashmir proper from 5 to 7,000' and I found it once in the Kishenganga Vy. at 6,000' and at Nil Nag at 6,800'. It resembles No. 43 but the rhizome is slowly but distinctly creeping, not erect. The

scales are numerous and hyaline, straight and curled. The sinus between the pinnules is wider than in No. 43 and also reaches nearer the midrib. It is found in the Lolab Vy. and in the Banir and Hapat Rai Nalas.

45. **A. setiferum** C. Chr.; (*Athyrium tenellum* Hope). A fern with an erect caudex with a mass of narrow dark coloured scales at the base of the stipes, fronds tufted. In cutting it resembles *A. filix foemina* but this species has strigules on the upper surface of the fronds and it is found at lower levels, from 4-7,000'. I have found it in Swat and at Serimang, Poonch.

46. **A. mackinnoni** (Hope) C. Chr. ; (*Asplenium mackinnoni* Hope 14 : 122, pl. 23, 1905 ; Bedd. p. 166 under *A. nigripes*). According to Hope the position and the shape of the sori and involucre together with the total absence of setae on the secondary rachises and costae are quite characteristic. This is a large fern with pale stipe and rachis, attenuate at tips of main and secondary axes, often 12 to 18" wide at base, basal pinnae a little shorter than the one above. C. Chr. says that it differs from *A. nigripes* in hippocrepiform indusia and light green lower surfaces. It is chiefly a fern from east of Kashmir but it has been collected in Changla Gali, the Kishenganga Vy., Gulmarg, Poonch and Pahlgam.

47. **A. rupicola** (Hope) C. Chr. (*Asplenium rupicola* Hope ; Bedd. Suppl. p. 35). A fern found in the crevices of exposed rocks, stems slender, brittle, grey straw coloured with many old, leaf bases. The pinnae are very gradually narrowed both ways, not truly bipinnate as the pinnules are not cut quite to the base. Duthie found this fern in the Siran Valley, Hazara. I found it in Baltistan near Olding, below a waterfall and near Dunga Gali, Hazara. Levinge reported finding it on the south slope of the Pir Panjal, possibly in Poonch. It usually grows at from 7-12,000'.

48. **A. filix foemina** (L.) Roth; Bedd. p. 168. The Lady Fern with various varieties is found in many parts of the Northern Hemisphere and is common in our area from Afghanistan eastward from 6 to 12,000'. The commonest form is var. *dentigerum* (Wall.) Clarke which is very abundant on alpine meadows. It has an erect caudex, not creeping as in *A. schimperii* which looks much like it. The fronds taper both ways, the stipes are black at the base as are the basal scales.

Clarke distinguishes a var. *retusa* with pinnules more deeply cut and a var. *attenuata* which Hope considers to be a form of var. *dentigerum*. If they can be maintained both these varieties are found in Kashmir.

49. **A. schimperi** Moug. ; (*A. filix foemina* var. *polyspora* Clarke) ; Bedd. p. 170 and Suppl. 35. This fern has been found from 5,500' to 10,500' from Swat eastwards but it is not nearly as common as it is further east where it is very common in oak forest as it is near Mussoorie. Abdul Hamid found it near the Murree water tanks ; in 1956 I found it in Thandiani, Hazara and it has been found in Poonch and Gulmarg.

50. **A. fimbriatum** (Hk.) Bedd.; Handb. Suppl. 37. 1892; (*Asplenium fimbriatum* Hk.). This is the largest and most divided of the *Athyriums* and is almost always above 10,000' in forests, though I once found it at about 9,000' above Bishigram in Swat. It develops and fruits late and most of the specimens in collections are immature. It has been collected in the Kishenganga Valley, in Swat and in various places in Kashmir such as Pahlgam, Gulmarg and Sonamarg.

Diplazium

51. **D. polypodioides** Bl. ; (*Athyrium polypodioides* Milde ; *Asplenium maximum* D. Don); Bedd. p. 184. This is also a very large fern, branched and from 3-6' tall, growing at lower altitudes from 5-9,000'. The young fronds are edible and are called "lingra". The plants grow in damp shady places and among boulders in stream beds. The species fruits freely and the caudex is stout and erect. Copeland places it in *Athyrium*.

52. **D. japonicum** (Thunb.) Bedd.; Suppl. p. 12. (*Athyrium japonicum* (Thunb.) Copeland). This is a very rare fern in our region having only been reported once from Panjal, Kashmir at 5,300' by Mc Donell, Aug. 1891. The rhizome is creeping, the fronds are hardly twice pinnate, the pinnules only being cut about half way down. The stipes are often longer than the frond being a foot or more in length. Hope says that it is not much of a *Diplazium*, meaning that the sori are mostly simple rather than growing on both sides of the veins.

53. **D. maximum** (Don) C. Chr.; (*Athyrium maximum* (Don) Copeland; *Asplenium latifolium* Don in part). Clarke states that '*latifolium*' is found from Kashmir to Bhutan but I have not seen any Kashmir specimens. Beddome says "like *D. polypodioides* only the secondary pinnae are generally much less cut down and often much broader, sometimes quite entire"

54. **D. squamigerum** (Mett.) Christ. ; (*Asplenium squamigerum* Mett.); A fine fern, tripinnate, triangular in outline with dark coloured scales and crenate pinnules growing in damp shady humus. The rhizome is creeping. Found from 6 to 9,000' It is not rare in the

Kishenganga valley from the Keran Nullah and Kel up to Koragbal and Gurais. I have also found it above Pahlgam in Kashmir among rocks in an avalanche gulley. Resembles *Athyrium crenatum* Rupr.

Asplenium

55. **A. viride** Huds.; Bedd. p. 143. A common alpine green stemmed, once pinnate fern found from Afghanistan and the Kurram eastward, growing in rock crevices.

56. **A. trichomanes** L., Ebony Spleenwort.; Bedd. p. 143. Another common fern but not seen much oftener as it is found as low as 3,000' though it has been found up to 12,000'. It is also found from the Kurram eastward and crosses the Himalayas to Gilgit and Baltistan. It is usually found in rock crevices in temperate forests of the outer ranges, sometimes on every rock. The rachises are a shiny black. Common also in Europe and America.

57. **A. septentrionale** (L.) Hoffm.; Bedd. p. 145. A common dwarf fern, much tufted, from the Kurram eastward on both sides of the Himalayas, growing in Chitral, Astor and Gilgit as well as on the southern slopes of the range from 8,000' to the snow line. It is found in the crevices of rock cliffs and boulders and is often mistaken for a grass as the fronds are divided into linear lobes. It is hard to extract the rhizome.

58. **A. rutz-muraria** L. Wall Spleenwort; Bedd. p. 156. Another wide ranging fern found from Afghanistan and the Kurram east to Nepal, often growing on limestone at altitudes from 5 to 14,000' ft. but not as common as the previous species. The tiny fronds are branching and the tiny lobes are rounded. It is another rock crevice plant in the open.

59. **A. breynii** Retz.; (*A. germanicum* auctt. including Bedd. Suppl. 31.; *A. septentrionale* x *trichomanes* auctt.). This plant was for a long time called *A. germanicum* Weis. but it was discovered that the plant of Weis. was No. 58. According to Alston the correct name is *A. breynii* Retz. Obs. Bot. 1:32, 1774. This is a very rare fern and as some have suggested it may be a hybrid. I have only found it once on a huge boulder in Pahlgam, Kashmir at 7,200'. Jerdon reported it from Kashmir without further data and Mc Donell reported it from the Kishenganga Vy. If it is a hybrid No. 57 is probably one of the parents, as like it the fronds are cut down to the rachis into a few distant, narrow, flabellate-cuneate pinnae on each side, the lowest of which are again deeply cleft. Like No. 56 the stipes are naked and ebenous.

60. **A. pekinense** Hance ; (*A. saulii* Baker ; *A. sarelii* Hk. ; *A. sarelii* Hk. var. *pekinense* C. Chr.) ; Bedd. p. 156. A rare, low level fern from about 2 to 5,000' suggesting *A. fontanum* and *planicaule*. The stipes are pale and the fronds taper both ways. It was found by Oertel at Dham-taur, Hazara and it has been found several times on the Jhelum Valley Road between Domel and Rampur. I have specimens but have never been able to find it.

61. **A. adiantum nigrum** L. ; Bedd. p. 156. A much commoner fern than the last having been collected many times from Chitral and Swat eastwards between 3 and 9,000'. The stipes are dark and it is common in the crevices of old walls and in pine forests. The sori are confluent when ripe and cover the whole surface of the segments. It is very common in the lower Kishenganga Vy.

62. **A. pseudofontanum** Koss. ; (*A. fontanum* (L.) Bernh.) ; Bedd. p. 158. Another widespread fern from the Kurram eastward and growing in Chitral, Gilgit and Baltistan as well as south of the Himalayas from 3,500' to 10,000'. It is near to *A. varians* but the fronds are a paler green, sometimes yellowish green in colour. The pinnae are more numerous and more divided. A rock crevice plant.

63. **A. varians** Hk. and Grev. ; Bedd. p. 158. This fern is even more common than the last especially on the outer ranges but it has a similar range from Afghanistan and the Kurram eastward from 4 to 12,000'. It is common on rocks in the forest, by woodland paths and on the bases of trees. It is dark green and delicately cut.

Ceterach

64. **C. dalhousiae** (Hk.) C. Chr. ; (*Asplenium alternans* Wall. ex Hk.) ; Bedd. p. 142. This is one of the commonest ferns of the outer ranges from 3 to 8,000' from the Kurram, Dir and Chitral eastward. It is one of the few ferns xerophytic enough to grow in the Salt Range and it grows in Astor and Gilgit. It is once pinnate, grows on banks and walls and is easily recognized by its alternate, undivided pinnae.

65. **C. officinarum** DC. ; (*Hemidictyum ceterach* Bedd.) ; Bedd. p. 194. This fern is less common than No. 64 but it has been found in a good many places from Armenia, Afghanistan and the Kurram eastward on both sides of the Himalayas from 3 to 9,000'. It is much like the last but is even more xerophytic. It is usually a darker green, has a thicker texture ; the lobes are shorter and broader and the lower surface is scaly rather than green. It is common in the lower Kishenganga Vy.

Actinopteris

66. **A. australis** (L. fil.) Link ; (*A. radiata* Link ; *A. dichotoma* (Forsk.) Bedd.) ; Bedd. p. 197. This is one of the few ferns which can live on the plains of India and as far as I know has not heretofore been reported from West Pakistan. It grows freely on the steep rocky west slope of Khairi Murat hill in Attock Dist. It does not look like any other fern. It is quite small with many radiating lobes like those of a dwarf fan palm leaf.

Woodwardia

67. **W. unigemmata** (Makino) Nakai ; (*Woodwardia radicans* (L.) Smith) ; Bedd. p. 135. A large, arching fern growing in damp ravines often near running water from Hazara eastward from 3,500' to 7,500'. It may be found with *Dryopteris rampans*, *D. erubescens*, *Polystichum nigropalaceum* and *Diplazium polypodioides*. Fronds may be up to 6 ft. long and bulbils form at the tips of the fronds or in axils along the rachis where roots may form. Because of the pattern of the sori it is often called "Chain Fern".

Gymnopteris

68. **G. vestita** (Wall.) Und. ; (*Syngramma* in Moore ; *Gymnogramma* in Hk.) ; Bedd. p. 386. Mouse Ear Fern. This is a rare fern in our area but it has been found in a few scattered places. Rodin found a specimen in Swat in 1952. Duthie found it on the Black Mt. in 1888. A friend told me that she had found it at Thandiani, Hazara Dist. but in a summer of collecting I failed to find it there. It may be overlooked as I found in Mussoorie that it was hard to see among grass and herbage until the new silvery leaves came up in August. The fronds are once pinnate and covered with short brown hair like that on a mouse's ear. It should be looked for between 5 and 9,000'.

Coniogramme

69. **C. intermedia** Hieron. ; (*Diplazium fraxinea* Don ; *Syngramme fraxinea* (Don) Bedd. p. 386 ; *Gymnogramma javanica* of Hope). Indian botanists have referred most specimens of this genus to the species '*fraxinea*' which is really a collective species with a great deal of variety in it. In our area the common form is No. 69. It may be found down to 4,500' but it is usually found above 6,000' and is twice or even tripinnate and up to 3' tall. The leaves of No. 70 may look like an ash leaf but the name '*fraxinea*' hardly applies to the higher level twice or thrice divided forms.

It does not seem to be common west of Kashmir. In Hazara I have found it at Thandiani at about 8,000' and it has been collected by Trotter many years ago in Murree. In Poonch I have found it near Bhedi and on the Hajipir and in an avalanche gulley at Pahlgam, Kashmir.

70. **C. affinis** (Wall.) Hieron. This is the low level form and though it looks very distinct there seem to be intermediates possibly through crossing. Typical *C. affinis* is only once pinnate except for the lowest pinna or the lowest two pinnae which are divided. I have found this form which has broader pinnae at 3,000' in the lower Kishenganga Vy., and in the Nawal Nadi, Poonch. Trotter found it on the Jhelum Valley Road. At Surkhala and Keran in the Kishenganga Vy. there seem to be intermediates. In Mussoorie No. 70 is found up to 7,000'.

Cryptogramma

71. **C. stelleri** (Gmel.) Prantl; (*Pellaea gracilis* Hk.; *P. stelleri* Baker); Bedd. p. 100. A delicate alpine fern found in the open among rocks and on rocky ledges from 9 to 13,000'. The rhizome is horizontal, white and delicate. The sori are marginal, the fertile fronds are similar to those which are sterile. It is common on both sides of the Himalayas and on the Karakorum.

72. **C. brunoniana** Wall. ex Hk. & Grev., (*C. crispa* R. Br.; Bedd. p. 98; *Allosorus crispus* Röhling; *C. crispa* var. *brunoniana* (Wall.) Fernald).

Another fine alpine fern, fronds tufted and dimorphic. The fertile fronds are taller and erect. It is common in rock crevices and in shallow soil under rocks, usually above 10,000' from Swat eastward.

Pellaea

73. **P. hastata** (Thunb.) Link; (*P. calomelanos* Link); Bedd. p. 104. This fern has apparently only been found once. It is a xerophytic fern with old leaf basis suggesting a miniature *Pteris* which I found on July 14, 1934 at 4,500' above Abbottabad in pine forest among rocks.

74. **P. nitidula** (Wall) Baker; Bedd. p. 101. A plant of the outer ranges, superficially like *Cheilanthes subvillosa* but lacks its hairs on the veins below. It also lacks the farina which most species of *Cheilanthes* have. It has been found from Swat and Kohistan eastward between 3 and 8,000'. It is not rare in Hazara.

Notholaena

75. **N. marantae** (L.) R. Br. ; Bedd. p. 373. This fern looks much like a species of *Cheilanthes* but it has a thick, red, hairy, creeping rhizome. The stipes are rather coarse and hairy, not scaly, becoming varnished when older. The fronds bear numerous transparent silvery scales on the midribs below, which turn reddish with age. Clarke reports this species from Kashmir but I have not seen any specimens from further west than Chamba. It is to be looked for from 8-11,000'.

76. **N. vellea** (Ait.) Desv. ; Bedd. p. 375. This is a very rare fern. I have only two specimens, one from Pangi and one from Chamba and I found only three specimens in Dehra Dun. At Kew there is a specimen of Jerdon's marked Cashmire. The fronds are 8-9 by 1-1 1/2", oblong lanceolate, bipinnate and covered on both sides, but especially the lower, with a whitish or subferrugineous tomentum. The rachis is more or less woolly and bright chestnut brown.

Cheilanthes

79. **C. pteridioides** (Reichb.) C. Chr.; (*C. fragrans* Webb and Berth); Bedd. p. 88. This is a xerophytic, Mediterranean type fern found from Madeira and the Canaries to Murree and Kashmir in the outer hills to about 5,000'. It grows in the Khyber, at Cherat, Margalla and Hasan Abdal. In the Lower Kishenganga Vy. it is common in Titwal in the crevices of walls with *Asplenium adiantum nigrum* and the two *Ceterachs*. It is green on both surfaces and the tiny ultimate segments are rounded.

78. **C. persica** (Bory) Mett.; (*C. szovitzii* F. & M.); Bedd. p. 89. This is another xerophytic Mediterranean fern found from South Europe and Asia Minor to Baltistan and Kashmir. It is found from 2 to 10,000'. It is found in the Peshawar and Attock Hills, in Chitral, Gilgit, Baltistan and Kishtwar as well as the Kashmir Valley. Much like the last but the lower surface of the fronds is covered with white to red woolly hairs which grow out of the sori.

79. **C. subvillosa** Hk.; Bedd. p. 93. This fern resembles *Pellaea nitidula*. It is found from Hazara eastward to China at altitudes from 5 to 9,000'. The stipes are densely tufted, with brittle, bright chestnut stems, 5-6" long. The fronds are without powder but the veins are hairy below.

80. **C. albomarginata** Clarke; Bedd. Suppl. p. 92. as var. of *C. farinosa*. This is another fern which is found from Hazara eastwards at altitudes from about 4 to 9,000'. In Mussoorie it is one of the commonest

plants on walls. Old fronds have little if any farina. The plants are often large for a *Cheilanthes* and they may have some yellow as well as some white powder. The elliptic scales on the stipes have pale margins.

81. **C. dalhousiae** Hk.; (*C. farinosa* var. in Bedd. p. 93). This species is usually found from 7 to 12,000' from Hazara and Murree to Nepal. It lacks white powder at all stages; the stipes are from 2-4" long and the fronds are 6 to 9" long and from 2 to 4" broad; acute lanceolate in outline. There are a few lax scales toward the base of the stipes; the involucres are deeply crenulate, toothed or laccate on the margins. I have found it in the Indus Valley in Baltistan at about 8,500'. It is also found in Hazara, the Galis and Thandiani.

82. **C. farinosa** (Forsk.) Kaulf.; Bedd. p. 92. This is the typical Silver Fern with the lower surfaces of the fronds a beautiful white. It is found from Hazara to Burma and is found from the edge of the plains to about 5,000'. It is reported from 11,000' in Kulu but it may have been *C. grisea* which some botanists consider to be only a variety of *C. farinosa*. The fronds are deltoid, the lowest pair of pinnae being the longest. The species is usually to be found on walls and rocks in the open. It grows on Mt. Tilla, in the Salt Range, Jhelum Dt. etc.

83. **C. grisea** Blanf.; Bedd. Suppl. p. 21; (*C. farinosa* var. *grisea* (Blanf.) C. Chr.). This species or variety has been reported from Hazara to Sikkim from about 3-11,000'. This plant and *C. anceps* are so much like *C. farinosa* that one cannot be sure about the correctness of published identifications as the three seem to intergrade and of course there may be hybrids. In this the stipes are said to be slender and the fronds dimorphous and powdered on both surfaces. This is the high level form in the Simla and Kumaon Hills but it has been reported more than once from Hazara as low as 3,000' in Mansera.

84. **C. anceps** Blanford; (*C. farinosa* Kaulf. var. *anceps* (Blanf.) C. Chr.). See Bedd. Suppl. 21. According to Hope *C. anceps* is stiffer and darker coloured as to stipes and upper surface of frond and more snowy white. The scales on the stipe are much more numerous, the fronds narrower and the lowest pair of pinnae not the longest. Plants are usually decidedly larger than in *C. grisea*. This form is rare in Pakistan but is reported from Hazara by Trotter and Oertel and from Mt. Tilla by Aitchison.

Onychium

85. **O. contiguum** (Wall.) Hope.; (*O. japonicum* Kze. var. *multisecta* Hend.); Bedd. p. 96. One of the commonest ferns in the outer ranges

in the temperate zone from 6 to 9,000' from Swat and Hazara eastward. It is very common and gregarious in the Murree Hills, the Galis and Thandiani, also in Poonch. In August it covers open hillsides and is abundant in thin forests. The fronds may be two feet tall and the segments are branched again and again so that it has been called Carrot or Lace Fern.

86. **O. japonicum** (Thunb.) Kze. This fern seems to be rare in our area. I have only found it in Serimang, Bagh Tahsil, Poonch at about 6,000'. This is much like the last species but it is much more coriaceous and many fronds last through the winter while the other species is herbaceous and dies down and does not appear again until the beginning of the monsoon. The fronds, too are less finely divided.

Adiantum

87. **A. incisum** Forsk.; (*Adiantum caudatum* auctt.); Bedd. p. 83. Found from the plains up to about 5,000'. This is a vigorous fern, spreading by the tips taking root and forming new plants. It is also the hairiest of our *Adiantums*. It is found from Swat eastwards to Burma.

88. **A. capillus veneris** L.; Bedd. p. 84. The commonest and most widespread of our Maidenhair ferns. It is often found growing on the walls of wells and on the banks of watercourses in the plains and Koelz found it at 12,500' in Ladak. It is usually abundant near waterfalls and on dripping banks throughout our area.

89. **A. venustum** Don; Bedd. p. 86. One of the commonest ferns in forests from 6 to 9,000'. It has been found as low as 4,000' and as high as 12,000', from Swat eastward.

90. **A. pedatum** L.; Bedd. p. 86. The handsomest of our *Adiantums* which is often called "Staghorn Fern" is the least common in our area. It is to be looked for in rich, shady forests from 7 to 10,000'. The only place I have found it to be fairly common is in the Kishenganga from about 6 to 8,000' from Sharda and Khel to Janawai. It has been found in Hazara at least twice and is reported from Gulmarg, Pahlgam, Aru and a few other places in Kashmir. The fronds are candelabra shaped and larger and handsomer than *A. venustum* which is usually found in drier forests.

91. **A. aethiopicum** L.; Bedd. Suppl. 18. This has only been reported by Aitchison from the Kurram Valley. I have never found it. The pinnules are said to fall off in drying.

Pteris

92. **P. vittata** L.; (*P. longifolia* L. in part); Bedd. p. 106. One of the few plains ferns and commonly cultivated in pots and beds in the Punjab plains. It is also found in the lower hills from Dir and Swat eastward, occasionally to 5,000'. This is a comparatively large fern and may be three feet or more in height, densely tufted with stipes covered with rusty scales.

93. **P. quadriaurita** Retz.; (*P. biaurita* var. *quadriaurita* (Retz.) C. Chr.); Bedd. p. 110. This is a common fern from Chamba eastward but has only been reported from our area by Trotter who reported it from Rattanpir, Kashmir at from 7,500' to 8,000'. Usually only the lowest pair of pinnae are four eared but in vigorous specimens others may be similarly divided.

94. **P. cretica** L.; Bedd. p. 106. This is very common in the outer ranges from Dir and Swat eastward from 3 to 8,000'. It often grows with *Adiantum venustum*. The fronds are dimorphic and the narrow lobed taller, erect fertile fronds look very different from the xerophytic, broader, sharply toothed sterile fronds.

95. **P. excelsa** Gaud.; Bedd. p. 114. This fern has only been reported once from the Siran Vy., Hazara, having been found by Inayat on 20-6-96. It ranges eastward to China and the Philippines. It is twice pinnate and the secondary pinnules are from 1 1/4 to 3" long, much larger than they are in *P. quadriaurita*. Plants may be 5-6' tall.

Pteridium

96. **P. aquilinum** (L.) Kuhn; (*Pteris aquilina* L.); Bedd. p. 115. Our form has been identified as var. *wightianum* Tryon. It is often very common on sunny grassy hillsides from 6 to 9,000' from Chitral eastward and also in Gilgit. I have found it down to nearly 3,000' in chir forest in the Kishenganga Vy. It is often very large and gregarious. Foresters say that the extension of this species is unfavourable for afforestation. The underground rhizome spreads widely sending up fronds at intervals.

Doryopteris

97. **D. ludens** (Wall.) J. Sm.; Bedd. p. 120. This is another example of a fern only reported once and that far to the west of its usual habitat. Gatacre found it in June 1895 in the Ziarat Vy., Chitral at from 5 to 8,000'. Students I have sent to Chitral have not been able to find it again and it

should be looked for. The leaves are entire or lobed with a heart shaped base.

Polypodium

98. **P. lachnopus** Wall. ; (*Goniophlebium lachnopus* J. Sm.); Bedd. p. 319. This is reported from Kashmir by Clarke and Beddome but neither Hope nor I have found it. It should be looked for in the Jammu Hills adjacent to Chamba. The rhizome is creeping and densely clothed with dark, long pointed scales in damp forest often hanging from trees.

99. **P. stracheyi** Ching ; (*P. stewartii* Clarke, non Bedd.) ; under *Pleopeltis malacodon* in Bedd. p. 363. A rare fern in our area. I have found it twice on cliff faces at about 9,000' at Pahlgam, Lidder Vy. Hope says "smallest of the group, stiffer, subcoriaceous, fronds do not hang down but stand up or spread out if growing on the face of a rock. Rhizome scales pale.

100. **P. nudum** (Hk.) Kunze ; (*Pleopeltis nuda* Hk. ; *Lepisorus nudus* (Hk.) Ching) ; under *Pleopeltis linearis* in Bedd. p. 346. This fern has linear coriaceous fronds which roll up from the margins in dry weather and unroll again when there is moisture. The ramentae of the rhizomes are ovate, entire and brownish, not subulate, long acuminate, ciliate and black as in the forms of 'lineare'. The fronds live through the winter and the plants are epiphytes or grow on cliffs. I have only found it at Nakial, near Kotli, Mirpur Dist. at about 5,000'.

101. **P. membranaceum** Don ; (*Microsorium membranaceum* (Don) Ching ; *Pleopeltis membranacea* in Bedd. p. 355). This large fern with undivided leaves growing on rocks and the bases of trees is very delicate in texture and bears numerous small scattered sori. Trotter and Gammie both report this fern from the Tawi Vy., Jammu from 4 to 5,000'. It is found ordinarily from Chamba to Burma.

102. **P. loriforme** Wall. ? ; (*Lepisorus* of Ching). I am still puzzled by the thick, coriaceous, linear leaved ferns of the 'lineare' complex. I have found specimens in the Ferozepur Nullah near Gulmarg and near Lidderwat in the Lidder Vy. which do not match Ching's picture of his *Lepisorus loriformis* which shows longer and narrower fronds. The fronds are so thick that no veins show and they bear clathrate scales.

103. **P. thunbergianum** Kaulf. ; (*Lepisorus thunbergianus* (Thunb.) Ching. ; under *P. linearis* in Bedd. 346). This resembles the last species. The fronds are linear, very coriaceous with hidden veins, the sori are very

large, covering the entire lower surface from middle to tip. I have found this or what I take to be this at Pahlgam and Fras Nag in Kashmir. More material is badly needed.

104. **P. excavatum** Bory ; (*Pleopeltis simplex* Bedd. p. 347. ; *Lepisorus* in Ching). Like the previous linear leaved forms this has not been reported from west of Kashmir and it has not been listed more than two or three times from Kashmir. It is herbaceous and the fronds do not last through the winter. East of Kashmir it is usually an epiphyte but those I have found in Pahlgam and Fras Nag grow on rocks and are thicker in texture than those in Mussoorie which grow on trees. It differs from the next species in the absence of clathrate scales.

105. **P. clathratum** Clarke ; (*Lepisorus clathratus* (Clarke) Ching ; *Pleopeltis* in Bedd. p. 348). This is the only linear *Polypodium* with a wide range in West Pakistan having been found in Gilgit, Hazara, Poonch, Kamri, Pahlgam, Sonamarg etc. from 7 to 13,000' on rocks. I believe that Kashmir 'clathratum' is what Clarke described and that the longer, more narrowly linear 'clathratums' from further east are different. Kashmir specimens are frequently only two or three inches long. The fronds are thin when dry and the veins and veinlets are distinct. Clathrate scales are found both in the sorus and on the rhizomes.

Pyrrosia

106. **P. mollis** (Kze.) Ching. *Nipholobolus fissus* in Bedd. p. 330). This is one of the few epiphytic ferns to be found west of Chamba. I have found it twice on *Machilus* at Serimang, Bagh Tehsil, Poonch at about 6,000'. The fronds are undivided as in the linear leaved *Polypodiums* but this is covered with a close tomentum on both sides of the fronds.

SCHIZAEACEAE

Lygodium

107. **L. japonicum** (Thunb.) Sw.; Bedd. p. 457. This is the only climbing fern which has been found in various places in W. Pakistan. It has been found from 2 to 5,000' from the Black Mt. and Mansera (Hazara) eastward to Burma on the outer ranges. McLeod found it in profusion near Domel and it has been found in Mirpur and Jammu.

108. **L. scandens** (L.) Sw.; Bedd. 455. This fern which is common on the Bengal Plains has only been reported by Gen. Gatacre from 5,000' at Ziarat, Chitral. If correctly identified its presence so far from its usual habitat is remarkable.

OSMUNDACEAE

Osmunda

109. **O. claytoniana** L. ; Bedd. p. 449. The Interrupted Fern is easily recognized by its having a number of pinnae half way down the fronds modified into special fertile, sori bearing bodies. It is a gregarious high level fern growing on grassy slopes at from 8 to 13,000'. It is not rare from Kagan Vy. eastward.

110. **O. regalis** has been reported from Hazara near Nathia Gali by Mr M. A. Kazmi. This is another interesting extension of range.

OPHIOGLOSSALES

Ophioglossum

111. **O. aitchisoni** (Clarke) d'Almeida ; (*O. vulgatum* var. *aitchisoni*). Mr Alston thinks that this may turn out to be the same as *O. polyphyllum* or *O. pumilum*. It is a plains species or in the outer, dry hills having been reported from the Kurram, Rawalpindi, Lahore and Tilla, Rohtas and Lehri in Jhelum Distt. Four to ten leaves may be borne annually in succession and the rhizome has persistent brown sheaths.

112. **O. petiolatum** Hk. I found this near Dhuli, Bagh tahsil in Poonch at about 4,000' in April 1952. The blades are deltoid, contracted into a cuneate base. Must be rare in Pakistan. I have also found it in Dharmasala just to the east of Kashmir.

Note. Clausen reports *O. vulgatum* L. from Kashmir. This should be looked for.

Botrychium

113. **B. lunaria** (L.) Sw. ; Bedd. p. 469. This cosmopolitan fern has been found a number of times from the Kurram eastward. It is often an alpine and has been found in Chitral on Tirich Mir, in the Karakorum and in Western Tibet. I have found it in the Kagan Vy. and was surprised to find it on the forest floor in Pahlgam at 7,200'. The barren, sessile segment is once pinnate, the pinnae are obovate and the blades somewhat succulent.

114. **B. virginianum** (L.) Sw. For many years it was felt that var. *lanuginosum* Wall. was the only West Himalayan form but Hope and others agree that the glabrous forms found in Hazara and Kashmir are true '*virginianum*' and not the pubescent, coarser form found commonly to the east of Kashmir. Inayat found No. 114 in Hazara and I

have found it on the Hajipir in Poonch and Canon Stokoe and I found it at Pahlgam. The species has also been reported from Kishtwar but I have not seen the specimen. This is a much larger species than No. 113 and both the sterile segment and the fertile segment are much more divided.

FERN ALLIES

EQUISETACEAE

Equisetum

KEY TO THE SPECIES

I. *Eu-Equisetum* : spikes obtuse, stomata not sunken

A. Barren and fertile stems very different, the fertile vernal, fugacious, spike 1 to 1/2''*E. arvense*

B. Barren and fertile stems alike

1. 6-12 square grooved ribs ; spike 1-12'' ...*E. diffusum*

2. Spikes about 1/2'' long, alpine.....*E. palustre*

II. *Hippochaete* ; spikes apiculate, apertures of stomata immersed.

A. Ribs prominent, narrow, very scabrous, plants 1 to 4 ft.; spikes sessile, 1/4 to 1' long.....*E. ramosissimum*

B. Ribs less prominent and less scabrous ; 1-10 ft. long, spikes usually subsessile, 1/4 to 3/4''*E. debile*

115. ***E. arvense* L.** This dimorphic species is circumpolar and is fairly common from Chitral and the Kagan Vy. eastward from 4,500' to 12,000'. The fertile segments come up early and soon die down while the much branched sterile fronds come up later. The rhizome is much branched and requires a damp soil.

116. ***E. diffusum* Don.** This is an eastern species which I found once in Nawal Nadi, Bagh Tahsil, Poonch at about 3,500'. It is common in stream beds in Mussoorie ; the barren and fertile stems are similar.

117. ***E. palustre* L.** This is the smallest of our species and I found it abundant in the Naltar Vy., Gilgit at 12,000'. It was identified by Alston who stated that it had been reported previously from the Karakorum. The cones are small.

118. ***E. debile* Roxb.** This species has been collected both in the plains and the hills to 9,000'. I find it very hard to distinguish from No. 119.

119. **E. ramosissimum** Desf. This has also been reported from the plains to 10,000'. It is supposed to be less rough and the spikes to be sessile. Baltistan, Ladak, Dras, Kagan, Skardu, Rawalpindi. The secondary axes are said to be ascending rather than at right angles as in No. 117.

SELAGINELLALES

Selaginella

120. **S. rupestris** (L.) Spring. This xerophytic species is reported from Chitral by Duthie. The stems are densely tufted and the leaves are very numerous and overlapping, pale, linear lanceolate, ciliate haired, dorsally keeled. The cones are acutely quadrangular and sparing.

121. **S. sanguinolenta** (L.) Spring forma **indica** (Milde) Alston; (*var. jacquemontii* Spring). An abundant and gregarious species from the Lowari Pass in Chitral and Swat eastward from 3,000' to 9,000'. Large quantities may be found on cliffs. The specific name comes from the reddish stems.

122. **S. sanguinolenta** forma **aitchisonii** (Hieron) Alston. The plants are taller and more slender than in the last, the leaves more acuminate and longer for their breadth. I have found this on cliffs at Pahlgam; Sonamarg and Baltal from 7 to 10,500'; also in the Kishenganga Vy.

123. **S. chrysorhizos** (Hk. & Grev.) Spring. Very common east of Kashmir where the monsoon is heavier than it is further west. It is occasional at Murree and at Aliabad in Poonch. It is close to the next species but this lacks the tuberous swellings which form on the stems and branches. In this the tubers are below ground.

124. **S. chrysocaulos** (Hk. & Grev.) Spring. I have not found this species which has been reported by Clarke from Basoli, Kathua Distt. Jammu at 6,000'.

LYCOPODIALES

Lycopodium

125. **L. selago** L. A circumpolar form which is occasionally found in the juniper zone above the tree line. I first found it at 13,000' above Sonamarg among dwarf rhododendron and in 1926 found it at Gulmarg between 12 and 13,000'. Koelz found it on the Burzil Pass at 10,000' and it has been collected in Gilgit and on Nanga Parbat but it seems to be rare.

MARSILEACEAE

Marsilea

126. **M. minuta** L. A very common water fern with four leaflets superficially resembling the leaf of a four leaved clover. It is abundant in rice fields and ditches and quiet waters in the plains and in the Kashmir lakes. Leaves formed after the water has partly dried up are smaller and the tips of the leaf lobes are toothed. Such plants have sometimes been thought to be different and have been called *M. erosa*.

SALVINIACEAE

Salvinia

127. **S. natans** (L.) All. I have only found this floating water fern in the Kashmir lakes.

Azolla

128. **A. pinnata** R. Br. This water fern is much smaller than *Salvinia* and it is common in roadside ponds between Gujranwala and Lahore and doubtless in other places.

DOUBTFUL SPECIES

In addition to the doubtful species mentioned in the text there is :

1. **Athyrium solenopteris** (Kze.) Bedd. p. 166 and Suppl. p. 33, a fern between *A. nigripes* and *A. tenuifrons* has been reported from Kashmir.

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Studies on the seed germination of *Corchorus* spp.

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Although the seeds of *Corchorus aestuans* L.(=*C. acutangulus* Lamk.), *C. trilocularis* L. and *C. depressus* Christensen (= *C. antichorus* Raeusch.) germinate readily in nature yet almost complete failure of germination was noted by us when the seeds of these species were sown in seedpans and in Petri dishes in our laboratory last year.

In an attempt to induce germination, seeds were treated differently with sulphuric acid, alcohol and also they were soaked in water for 24 hours before their sowing but none of these methods proved successful in bringing about the germination. An experiment was then designed in which half the seeds of *C. depressus* and *C. aestuans* were rubbed between sandpapers and half were left unrubbed before they were placed for germination in Petri dishes and in pots. Of all the pots and Petri dishes half were placed in the sun and half in the shade. Seeds were supplied with abundant water in half of the Petri dishes and pots and in the remaining half of Petri dishes and pots very little water was added. The results of the experiments are shown in table No. 1.

Scarification i.e. rubbing of seeds between sandpapers was successfully employed recently along with alternate temperature treatments in bringing about germination in seeds of *Asphodelus tenuifolius* Cav. (Khan & Chaudhri, 1957). Smith (unpublished) was able to increase the percentage of germination in seeds of *Trifolium repens* by means of scarification.

RESULT. It is quite evident from Table 1 that germination was only recorded in "rubbed seeds" irrespective of whether they were placed in the sun, shade, sand and soil. In the table results of the effect of abundant and low moisture to the rate of germination of seeds have not been shown as the difference did not affect the germination rate. The seeds of *C. trilocularis* were also found to readily germinate when rubbed between sandpapers as against their absence of germination in untreated seeds. Detailed data on *C. trilocularis* have not been collected.

TABLE 1. GERMINATION OF SEEDS

	In the sun			In the shade				
	Seeds without rubbing		Rubbed seeds	Seeds without rubbing		Rubbed seeds		
	No. of seeds kept for germination.	No. of seeds germinated.	No. of seeds kept for germination.	No. of seeds kept for germination.	No. of seeds kept for germination.	No. of seeds germinated.		
<i>C. depressus</i> <i>C. aestuans</i>	20	...	20	13	20	...	20	11
	20	...	20	18	20	...	20	16
	SEEDS PLACED IN POTS							
	40	...	40	38	40	1	40	28
<i>C. depressus</i>	40	...	40	29	40	...	40	33

CONCLUSION. The three species of *Corchorus* in question are wild. The seeds being very light are blown away by the wind of high velocity from one place to the other and during their dispersal, the seeds get rubbed against the soil particles. This probably is the reason why in nature they germinate abundantly whereas in the laboratory no germination takes place without rubbing of seeds.

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Fasciola indica Varma, a synonym of *Fasciola gigantica* Cobbol*

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INTRODUCTION

Cobbold (1855) described the species, *Fasciola gigantica*, from several specimens of flukes recovered by him from the liver of a giraffe during a postmortem examination nine days after the death of the animal. Cobbold is stated to have recovered no fewer than forty specimens from the liver by washing out by means of a syringe. The following description of the species, corresponding to the original, is reproduced from Stiles (1894).

The parasite varies in length from $1\frac{1}{2}$ to 3 inches, averaging 2 inches; the breadth averages 3 lines but may be one-third of an inch; substance of the body is thinner than that of *F. hepatica*; anterior extremity prolonged forward, oral sucker half a line in diameter. Oesophagus short, 8 to 10 lateral branches to each longitudinal sac. Excretory system consists of a single median trunk which sends branches upward and toward the sides; other organs resemble in all respects those seen in *F. hepatica*.

Railliet (1895) found an elongated fluke in Senegal in cattle and provisionally named it *F. hepatica* var. *augusta*. Looss (1896) described a fluke from cattle at Cairo and named it *Fasciola hepatica* var. *aegyptiaca*. Blanchard (1896) suggested that both the varieties were, in reality, the same as Cobbold's *F. gigantica*. Looss (1902) after examining a large number of specimens from the Cairo abattoirs accepted Blanchard's suggestion and withdrew the species *aegyptiaca*.

Jackson (1921) re-examined Cobbold's type material and also the material of *Fasciola* from Rangoon, Rhodesia and Nairobi and concluded that the material from both Burma and Africa belonged to the species *F. gigantica*. Varma (1953), however, aroused fresh interest by differentiating the material from India, Malaya and Burma from that of Africa, and assigned the material from the former regions to a new species which he designated as *Fasciola indica*. For a differentiation of the two species, however, Varma (1953) relied solely on the material that was available to him for examination and nearly overlooked the variations which

* A part of the Thesis approved by the University of London for the award of the degree of Ph.D. This work was done at the London School of Hygiene and Tropical Medicine.

Jackson (1921) had pointed out in *F. gigantea* from African localities. The present study reveals that Varma's *Fasciola indica* is synonymous with *Fasciola gigantea*.

MATERIAL

The material examined by the author was collected from a buffalo at Kahuta (District Jhelum—West Pakistan). A mounted specimen collected by Dr M. Abdussalam from sheep at Mukteswar was also available for examination. For purposes of study the author exercised his discretion in selecting ten specimens which appeared to show different grades of variations.

OBSERVATIONS ON TAXONOMIC CHARACTERS

EXTERNAL FEATURES. Varma (1953) defined the general contour of *F. indica* as intermediate between *F. hepatica* and *F. gigantea*. He described the shoulders as characteristic of *F. hepatica* and distinctly prominent in *F. indica*, while, in *F. gigantea*, he found the shoulders to be indistinct or absent. Jackson (1921) who re-examined Cobbold's material comprising three specimens, described the shoulders in two of them. In one specimen "there (were) no distinct shoulders", while in the other the "cone (was) cylindro-conical and mounted on sharply projecting shoulders as shoulders." In the Rhodesian collection, Jackson (1921) described the "very slight", though in another Rhodesian specimen (Jackson's text-fig. 3) the shoulders are broad. Jackson found that "no shoulders (were) present" in the specimens from Nairobi.

The author's material shows all degrees of variations in this character: two of the specimens, one with prominent and one with indistinct shoulders, are reproduced in fig. 1.

Varma described the anterior short conical portion in *F. indica* as more massive than in other related forms, while in Jackson's drawings from his African material the anterior cones in different specimens show considerable variation. The anterior cones in Jackson's drawings of his Rhodesian specimens show a striking similarity to those in Varma's text-figures for *F. indica*. In the author's material the anterior cones show a great deal of variation in different specimens, evidently on account of fixation.

Varma described the sides of the body in *F. gigantea* as roughly parallel and the posterior extremity as bluntly rounded, but, in *F. indica*, the body was stated by him as gradually decreasing in width from the level of its transverse vitelline duct to its hind end. In Jackson's text

A STATISTICAL COMPARISON OF MEASUREMENTS OF EGGS OF *FASCIOLA GIGANTICA*

(All measurements, except where otherwise indicated, are in microns)

	Varma, 1953				Material from Pakistan			
	<i>Fasciola gigantica</i> (20 eggs dissected out of uterus)		<i>Fasciola indica</i> (20 eggs dissected out of uterus)		<i>Fasciola</i> eggs (30 eggs measured inside the uterus)		<i>Fasciola</i> eggs (30 eggs collected from the bile duct)	
	Length	Breadth	Length	Breadth	Length	Breadth	Length	Breadth
Range	150-190	78-95	140-165	95-112	140-165	72-95	140-170	85-110
Mean	166.3	88.3	155.2	102.4	147.61	88.3	154.0	92.12
Standard deviation	11.3	5.0	7.0	4.6	6.22	7.26	7.71	6.86
Standard error	2.5	1.1	1.6	1.0	1.46	1.71	1.38	1.23
Variance					38.82	52.94	59.48	47.09

A. Measurements of eggs of *Fasciola gigantica* by Jackson (1921).

1. Cobbold's specimen 0.145-0.150 X 0.082-0.088 mm.
 2. Rhodesian specimen 0.150-0.170 X 0.070-0.085 mm.
 3. Rhodesian specimen 0.130-0.175 X 0.075-0.090 mm.
- B. Measurements of eggs of *Fasciola gigantica* from Hawaii, quoted by Alicata (1938)
- 156-197 X 90-104 μ (eggs recovered from gall bladder).

figure 4, representing a Rhodesian specimen, the body has its greatest width near the anterior end and then it tapers very gradually to a blunt tail end. In the other Rhodesian specimen Jackson (1921) described the body as "soon reaching its full width and retaining it for one third of its length and then tapering posteriorly to a bluntly pointed tail." In his text-figures I & 2, representing Cobbold's material, the body is gradually tapering in one and almost parallel in the other. In the author's material, all grades of variation, ranging from gradually tapering to parallel sides, were found to occur.

SIZE. According to Varma, *F. indica* shows affinity to *F. hepatica* in average dimensions. However, he stated at the same time that some examples corresponded to *F. gigantica*. But he did not quote measurements either for *F. gigantica* or for *F. hepatica*. The measurements from the author's material, showing a wide range of size, are given below :

Length (mm.)	Breadth (mm.)	Ratio of breadth to length
38	11	1:3.4
41	7.5	1:5.4
33	5	1:6.6
21	7	1:3.0
44	7	1:6.3
39	10	1:3.9
35	10	1:3.5
27	8	1:3.4
30	8	1:3.7

The differences in the size of specimens may be partly attributable to the age of the flukes but the ratio of length to breadth is evidently influenced by fixation.

CUTICLE. Varma described the scales in *F. indica* as broader and stouter and more bluntly edged than those of *F. hepatica* and *F. gigantica*. Varma stated, at the same time, that "their variations in shape and size have already been indicated but it is suggested that by a suitable comparative study the three species could be differentiated one from the other by this character." Varma, however, makes little mention of the nature and

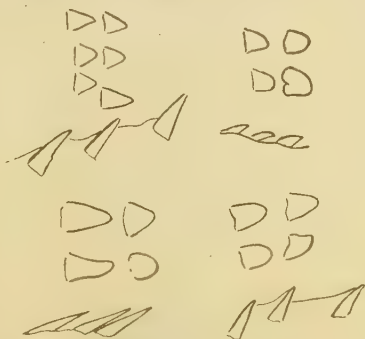


FIG. 2. Cuticular scales drawn from acetabular region of four specimens of *Fasciola gigantica* from Pakistan.

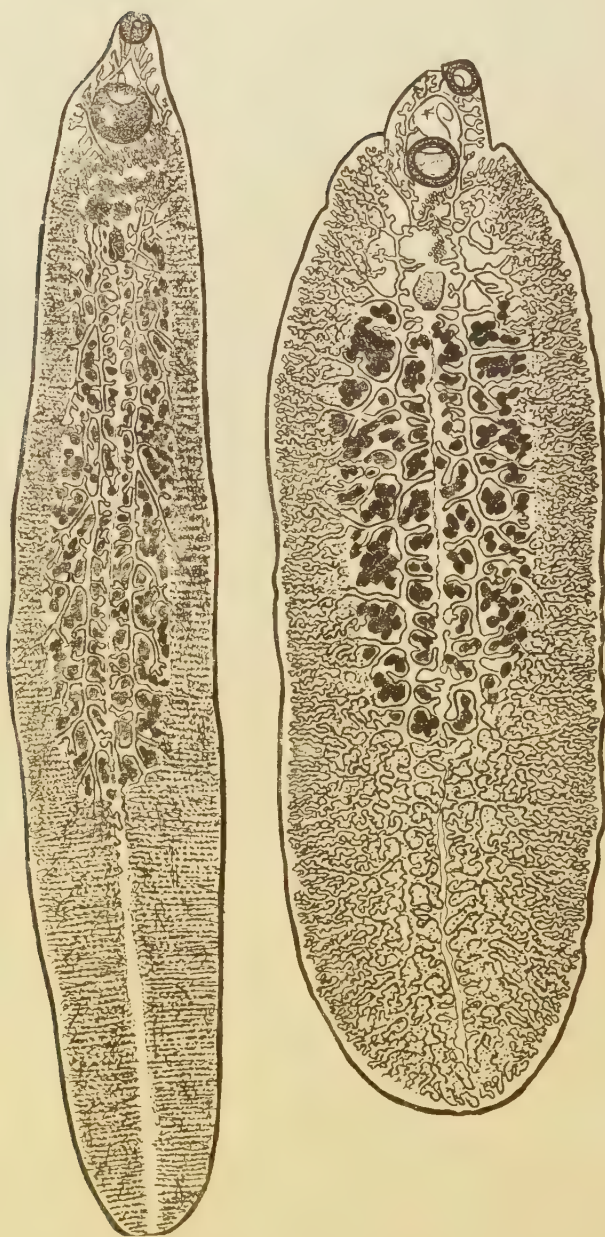


FIG 1. Camera lucida drawings of two specimens of *Fasciola gigantica* from Pakistan.

extent of variations in the scales of the three species. The scales, for each of the three species, are drawn to a uniform shape in his text fig. 6. In the present author's material there were considerable variations in different specimens and the shape of scales in four of the specimens, from the region of acetabulum, are reproduced in fig. 2. There is apparent resemblance between some of these drawings and those of *F. gigantea* by Varma (1953 : text-fig. 6).

INTESTINE. Varma found the number of branches in *F. indica* to be fewer than those in *F. gigantea*. He quoted the number of principal lateral branches in *F. indica* to be 15 but he did not quote any figures for *F. gigantea*. On the other hand, Cobbold (1864) quoted the number of lateral branches in *F. gigantea* to be 8-10 but in his text-figure 2 as many as 14 branches can be counted. In Varma's text-figure of *F. gigantea*, as many as 20 branches can be counted, while, there are, respectively, 16 and 17 branches in his drawings of *F. indica*. In the author's material the number of lateral branches in five of the specimens were, respectively, 14, 15, 15, 17 and 22.

Varma pointed out the direction of the course of gut branches as of a specific differentiating value in the three *Fasciola* species. According to Varma the branches in *F. gigantea* take a course which is at right angle with the main stem while in *F. indica* the course of branches shows an angle of 45° with the main stem. In the author's material the direction of branches showed different angles in different specimens and two of the specimens reproduced in fig. 1 show a wide contrast. It appears that the direction of the intestinal course is influenced by the state of contraction of the specimens. For example, one of the specimens represented in fig. 1 (a) is longitudinally stretched and the lateral branches are consequently bent at an acute angle, while the specimen represented in fig. 1 (b) is longitudinally contracted, and, the lateral branches are straight and horizontal. The contention of Varma that the branches are horizontal in *F. gigantea*, does not appear to be borne out by Cobbold's (1864) drawing, (frontispiece), in which the branches show an angle of 45° in the direction of their course.

GENITALIA. According to Varma the area covered by the testes in *F. indica* is less than half the total length of the body, while, in *E. gigantea* this area is about half the length of the body. In the author's material the length covered by the testes in relation to the total length of the body and their ratio were found to be as follows :

Total body length (a)	(Measurements in millimeters)		Ratio (a : b)
	Length of body	covered by testes (b)	
33		15	1:0.45
38		18	1:0.47
41		20	1:0.48
30		14	1:0.46
21		9	1:0.42
44		17	1:0.32
39		20	1:0.51
35		13	1:0.37
28		11	1:0.39

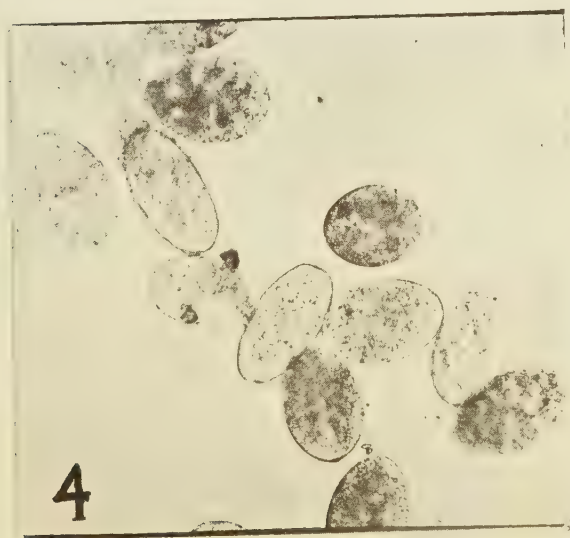
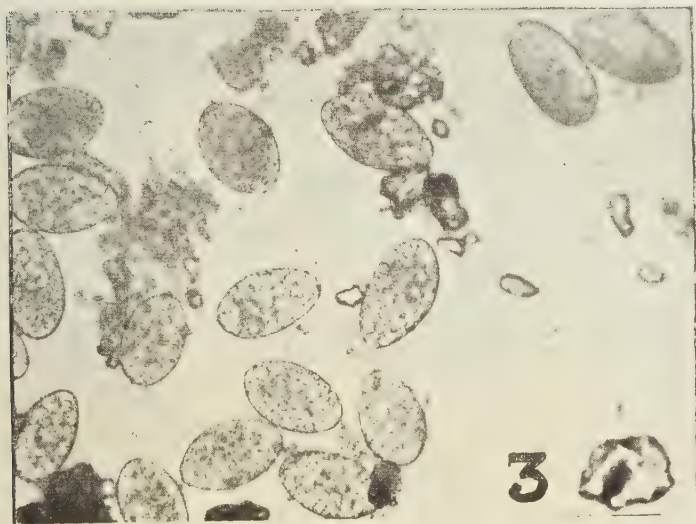
The above figures show considerable variations in the proportion of body length and the area covered by the testes. It would also appear that the length to which the testes extend is less than half the total length in the shorter forms but more or less equal to half the length in the larger forms. It may be pointed out that Varma did not quote the figures on which he had based his conclusions.

EGGS. Varma found the eggs in *F. indica* to be much broader than those of *F. gigantica*. A photograph of the *Fasciola* eggs (figs. 3 & 4) collected by the author from two buffaloes, one at Lahore and the other at Rawalpindi, would clearly show a wide range in the shape of the eggs in the two samples. The two eggs at the top right corner of the photograph (fig. 3) and a number of such eggs in fig. 4 appear to conform to the shape of the eggs ascribed to *F. gigantica* by Varma. The measurements by Varma and those of the author have been statistically arranged in the text elsewhere and a study of these figures would show that the mean breadth of 88.3 compiled from the author's material, conforms exactly to the mean breadth of eggs of *Fasciola gigantica* given by Varma.

It would appear, the measurements (the ranges in size of eggs) by Varma (1953), Alicata (1938), Jackson (1921) and those of the author, are intergrading and no distinction could possibly be made in the materials from different sources on the basis of eggs. As a result of these observations, it is concluded that the *Fasciola* materials from Indo-Pakistan and Africa are taxonomically identical.

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Some Observations on Debudding and Pruning as an aid to get a clean Bole in some Native Hardwoods

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Debudding has been known in horticulture since long but in forestry this practice as a regular feature is almost non-existent. During the recent years the significance of debudding in forestry is coming to be recognized increasingly. Some projects going on in the various countries have shown that it is a workable practice in forestry, provided it is judiciously carried out, and factors like the kind, vigour of plants, age, site, period of debudding and frequency are taken into consideration. This operation has been given various names, such as *disbudding*, *debudding*, *bud pruning* or Krotkerich's pruning. It involves the removal of buds or young shoots from certain portions of the plant, especially the trunk, and thus improve the grade of timber. It is continued for a period with variable frequency till a desired length of clean bole is produced. Work done in various countries further emphasizes the need for an early operation to produce a clean bole. In this connexion some work can be cited to elucidate the point.

Onaka (1950) has reported that in *Pinus thunbergi*, the removal of all buds but leaving the old leaves intact, caused a reduction in growth and later in the growth period. Of course, the complete removal of buds and leaves throughout a tree stopped growth at once.

Chapman & Taylor (1951), after 9 years of experiments found that pruned trees were not significantly shorter than unpruned, but current growth was slowing up. It was considered that it should be practicable to prune for 10 years so as to obtain a clear 16 ft. long bole. Nicholson (1951) tried some experiments and brought out the disadvantages of the method.

The work of Glattfelter (1952) on *Pinus strobus*, *Pinus resinosa* and *Larix leptolepis* gave no evidence that twig pruning was better than bud pruning on pine. Work in British Columbia (1952) indicates that

disbudding and pruning combined tended to reduce the growth in length (by 14.3 %) and mid-diameter increment (by 16.7 %). In taller trees (10-12 ft.) the leader did not recover the severe bending to which these were subjected during dis-budding.

Bickerstaff's (1952) results on debudding of Red pine indicate that it was possible to obtain a completely knot free long length by disbudding in a period of ten years. The treated trees were of better form but smaller diameter than controls. He recommended dis-budding only in fast growing plantations on a good site. The treatment should begin when average height is 3-5 ft. and spacing 8×8 to 9×9 ft.

Meckenenzie (1953) working on 7 years old Scots pine found that disbudding for 3 years, by which time the tops were out of reach, produced 5 ft. 9 inches of wood, clear of knots. If the operation was started at the age of 5 to 6 years, 7 ft. clear wood could be obtained. This would be practicable only if the price fetched would cover the increased cost of labour.

Recently Kadambi & Dabral (1954) have reported preliminary observations on debudding of *P. longifolia*. They have reported that height growth is not adversely affected by the annual debudding when compared to no debudding. Debudding increased the formation of epicormic shoots and becomes difficult operation after some time.

In the present studies preliminary observations on limited number of Mulberry (*Morus alba*), Bakain (*Melia azedarach*) and Amlok (*Diospyros lotus*) trees were made for a period of three years and are reported in the following paragraphs.

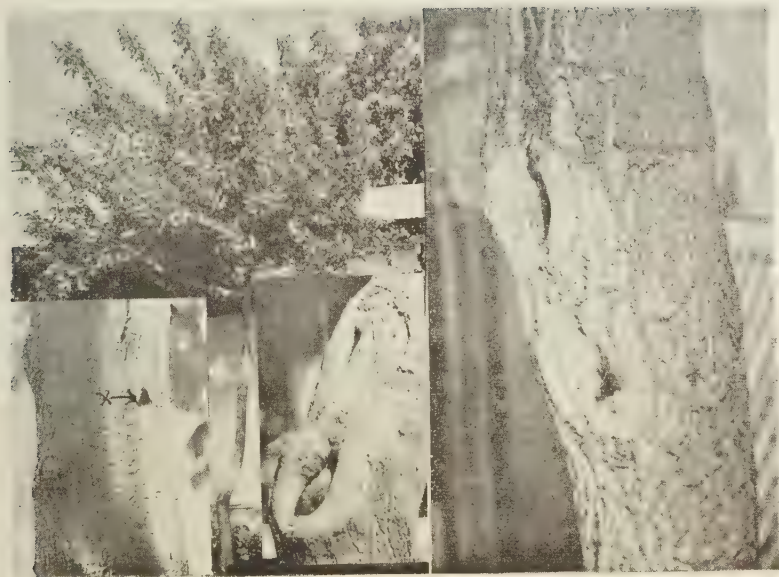
Mulberry—(*Morus alba* Linn.)

Mulberry is a fairly fast growing tree which is an important source of wood for sports goods, furniture and turnery. The tree is well known for its coppicing power and production of adventitious shoots from the main stem as well as other exposed parts and roots crown. Observations were conducted under Abbottabad conditions (semi temperate) where the trees of good size and vigour exist.

In the plantations of the former Punjab pruning and thinning are combined operations done in a very crude manner so that in majority of cases large jagged wounds are left on the trees. In addition to this, coppice shoots and adventitious branches start coming out from near the cut branch stubs and other places on the stem. Therefore, pruning has

to be repeated a number of times. Pruning is a tedious process and requires good skill. The tree in Fig. 1 shows pruning of various grades, and the wounds are healing up (fig. 2), the callus formation is good. In the third year the large pruning wound is seen to be almost occluded (figs. 3 & 4). The best form of bud pruning which the author has tried, was in the early stages of primordial swellings for branch formation as seen in figs. 2, 13 and 14 marked X. The branch primordium arises as a roundish pyramidal dome from the living bark. This may take one or two seasons to grow into a branch. This is the stage when it is easiest to destroy the potential unwanted branch and can be done even with the help of a small pen knife. The swollen primordium is shaved off the surface, with one stroke as seen in fig. 13, marked A. This leaves a clear surface wound which heals off in a short time. This practice is much easier than cutting off branches one inch or more in thickness with a hatchet or saw. The tree shown in fig. 1 was profusely branching and bushy with many epicormic shoots coming out from all and sundry places on the main stem. Pruning in case of large limbs (3 inches in diam.) was done flush with the stem and it can be seen that in three years time most of the wounds have almost healed (fig. 4). Though the bole had been deformed in early stages as seen in fig. 1 yet it is clean after debudding and pruning. In pruning large branches the risk of establishment of heart rots is great and, therefore, pruning in early stages of branch formation is a proposition which should commend itself and be given serious consideration. Bad pruning, leaving jagged wounds and long tails (figs. 5 & 6) is worse than no pruning at all, because it exposes the tree to heartwood decays. In carrying out bud pruning over large areas, trained debudding squads have to go through the plantation and remove the branch primordia systematically. A single tree does not take more than a couple of minutes to complete the operation and inspection.

It has been found that the excision of buds on the stem is best done in spring in case of mulberry when the sprouting and leafing season is on (February and March). The swollen primordia can be easily detected and sliced off. This is easier and boles up to 8 ft. can easily be taken care of by men without any other aid. Another 3 to 4 ft. can be debudded by the use of hooked or loop knives (as shown in the figs. 7 & 8) with attached 3 ft. handle or a chisel with long handle. The work of debudding gives a cleaner bole without the risk of establishment of heart rot which usually starts from the stubs and jagged wounds. In debudding no adverse effects were seen.



2

1

3

4



5a

5b



8



7



6

A.H. Khan—Observations on debudding



10

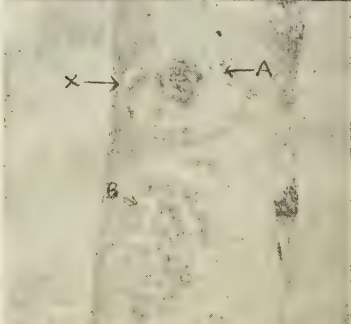
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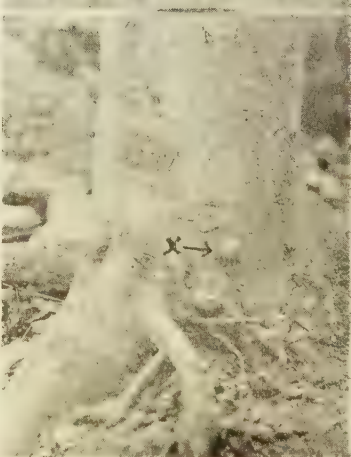
12



11



13



14

Removal of young Sprouts :—Taking into consideration the fact that the period of debudding may necessitate more labour, which may not be forth coming, nipping of young shoots which were *still tender and crisp* was also tried. It has been found that shoots 1 to 12 inches long and 1.4 inch in diameter could easily be broken off with hand. This leaves an irregular wound which heals off but is not as smooth and sanitary as the excision of the buds (fig 11). It should preferably be smoothend.

Bakain—(*Melia azedarach* Linn.)

This tree is quick growing and coppices well from stumps of 8 to 12 in. diameter. In practice the coppice shoots arise in quite a number and ultimately all but the dominant one, have to be removed during thinings (figs. 10 & 11). This needs extra thinning which can be eliminated by early debudding (February-March) with knife, leaving the most active sprout. Callus formation and new shoots primordia continue to be formed in this species and have to be removed at least thrice in quick succession till the summer sets in. The young sprouts tend to develop a bushy growth, therefore in order to promote lengthwise growth lower young branches arising in the axil of the lower leaves should be excised leaving the leaves intact. Another round of observations is needed during the months of July and August to knock off any stray shoots that may develop on the stem or on the old stumps. Trained squads can easily scan through the plantations and remove new primordial buds, or young twigs if seen. The operation is not a time consuming one but frequency of rounds has to be adjusted according to the local conditions. In Abbottabad the repetition is needed after 3-4 weeks.

Once a clean bole is set, it will hardly be necessary to take note of the tree and easily a clean bole of more than 12 ft. develops from early debudding (fig. 9). In the second year the lowest whorl of branches is pruned off leaving the upper whorls to continue. This helps in continued growth without serious ill effects.

Amlok—(*Diospyros lotus* Linn.)

Amlok is another fairly quick growing species of the area. It sends out many epicormic shoots from the bole as well as from the exposed roots and root crown. The frequency of sprouts is more in the latter case. As in mulberry, small root and shoot primordia can easily be marked out (fig. 13 & 14, marked X) and removed with a knife. This operation is necessary once a year for a couple of years. Young branches

one inch or less in diameter are removed from the lowest whorl, leaving $\frac{2}{3}$ of the crown intact. The clean bole so produced after three years can be seen in fig. 12. Debudding was done in the month of March, and found effective.

DISCUSSION

The preliminary observations recorded for a period of three years further confirm that debudding is a practice which has a definite place in forestry where clean and knotless boles of timber are needed. These observations are supported by the earlier works of Chapman, Onaka, Nicholson, Meckenzie, Bickerstaff and others cited previously.

Debudding if carried out too often may be detrimental to the growth of some trees (Kadambi, Bickerstaff and Onaka). The slowing up of growth however is compensated by the cleaner bole and better market value. Unless this advantage exists, the extra cost on production will not be warranted. However judicious spacing of operations during the year by noting the sprouting or coppicing habit of the trees, period of growth, etc., can minimise the adverse effects. In the present experiments no ill effects, as noted in many of the conifers, have been observed but more extensive trials are needed for offering more authentic verdict on cost accounting. The time required for debudding is very small, a matter of a couple of minutes or so per plant, and the results are encouraging to warrant judicious adaptation of this practice in forestry. Further work is necessary on various species in order to formulate schedules for this operation.

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Description of two new species of *Bruelia* in the collection of the British Museum (Natural History), London

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INTRODUCTION

The interesting material which forms the basis of the following account consists of six slides of mallophagan parasites. Two slides (containing 4 specimens) were collected from *Gracula religiosa intermedia*, one (containing 2 specimens) from *Gracula religiosa* Linn. and the rest (containing 7 specimens) were obtained from *Philostomus afer* (Linn.). For this material I am indebted to Dr Theresa Clay, to whom I wish to express my thanks with gratitude.

Bruelia moreli sp. nov.

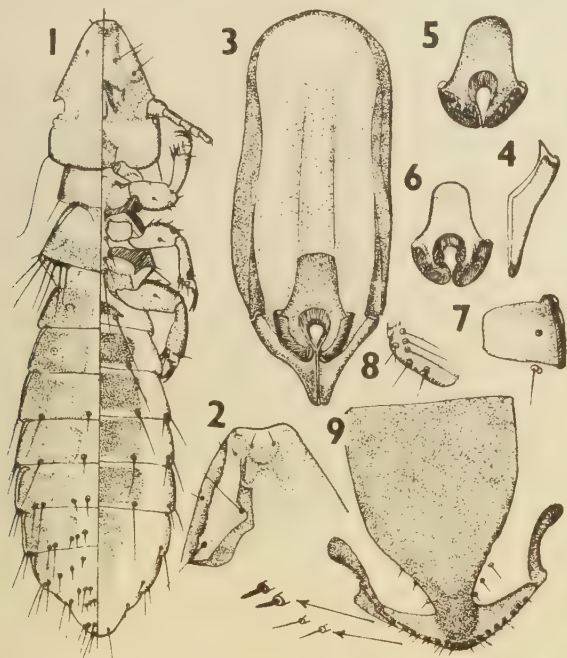
(Text-figs. 1—9)

TYPE-HOST : *Philostomus afer* (Linn.).

HOLOTYPE (MALE) : 1.371×0.379 mm., delicate and feebly sclerotized. Tergal, sternal and pleural plates well developed, marginal carinae well formed. Head triangular, of the fir cone in shape, with rounded frontal margin 0.348×0.267 mm., cephalic index 1 : 0.767. Clypeal region with sides straight or slightly concave. Marginal carina well developed, wide and comparative heavily sclerotized proximally and narrow in front, interrupted medially, anterior margin at this point hyaline and with greater median modification. Preantennary area 0.179×0.225 mm., index 1 : 1.257. Antennae showing very slight sexual dimorphism. Hind head 0.169×0.267 mm., index 1 : 1.579. Temples straight, latero-posterior angle rounded. Preocular nodus and postocular nodus well developed. Marginal temporal carina well formed. Posterior margin convex. The number and arrangement of setae as in other *Bruelia* species. Eyes obscure, ocular seta present.

Prothorax 0.098×0.205 mm., transverse. Frontal margin extending considerably under the occiput, sides straight, slightly divergent, latero-posterior angle with a long and fine seta. Posterior margin convex. Pterothorax 0.138×0.267 mm., trapezoidal, sides nearly straight and

strongly divergent, latero-posterior angle rounded and set with a slender spine and a long seta. Posterior margin flatly rounded and slightly



Text-figs. 1-9. *Bruelia moreli* sp. nov. (1) Dorsal and ventral aspects of male, (2) fore-head of the same (enlarged) showing modifications, (3) male genital armature, (4) paramere, (5-6) two different aspects of mesosomal plate, (7) VI tergal plate of female. (8) ventral views of IX pleural plate showing arrangement of setae. (9) subgenital plate of female showing marginal chaetotaxy.

angulating medially, with five submarginal setae beset as shown in the figure. Legs of medium size with slightly curved claws.

Abdomen 0.836×0.379 mm., oblong, segments II-IX well formed, X-XI fused together. II-VII pleurites well developed, segments II-IX with well developed tergal plates, all interrupted in the middle, II-VII quadrate, VIII slightly reduced and more or less subquadrate, IX triangular. Segments X-XI without tergal plates. III-IX tergites with functional spiracles, submarginal in position. Tergal plates II and III bare, IV and V with one post-spiracular and one tergo-central seta, VI with two post-spiracular and two tergo-central, VII with two post-spiracular and three tergo-centrals, VIII with a row of four setae, IX with one in the lateral

angle, three setae beyond, equidistantly arranged, X-XI with three short and delicate setae. Pleural plates II and III bare, IV-VII with one ventral and a dorsal seta on each side, VIII with one dorsal, one lateral and a ventral seta, IX with one anterior and a posterior seta, X-XI rounded, posterior margin with one dorsal, two marginal and two ventral setae on each side of the middle line. Ventral chaetotaxy scanty, setae short and delicate, sternal plates well developed, II reduced, narrow, moon shaped, II-VI quadrate, each with a seta in the latero-posterior angle. Other sternal plates fused to form a conical subgenital plate.

Male genitalia 0.2302 mm. long, very small and delicate, similar in many respects to the type found in *Bruelia deficiens* (Piaget) and other allied forms. Basal plate 0.1682 mm. long, anterior width 0.0857 mm., posterior width 0.0651 mm. Parameres short, slender with simple proximal heads as shown in the figure, straight length 0.0539 mm. and oblique length 0.0635 mm. Mesosomal plate 0.0476×0.0397 mm. (greatest width), of the pattern found in *Bruelia zohrae* Ansari.

ALLOTYPE (FEMALE) : The female is similar to the male, but differs in the measurements and abdominal chaetotaxy, 1.811×0.472 mm. Head 0.394×0.272 mm., cephalic index 1 : 0.691. Preantennary area 0.205×0.255 mm., index 1 : 1.244. Hind-head 0.189×0.272 mm., index 1 : 1.439. Prothorax 0.098×0.231 mm., with a seta in the postero-lateral angle. Pterothorax 0.169×0.277 mm., with 5+5 sub-lateral setae, one spine and a long seta in the latero-posterior angle. Abdomen 1.189×0.472 mm. Tergal plates II-IX well developed, II-VIII interrupted in the middle, IX entire, II-V bare, VI and VII with post-spiracular seta, VIII with one small, one long and two short setae, IX with three subequal setae on each side of the middle line. Pleural plates well developed, II-III bare, IV with one, V-VII with one dorsal and one ventral seta, VIII with one dorsal and two ventral setae, IX with one dorsal and a group of five setae on the ventral aspect. Subgenital plate simple, shield shaped with meniscus posterior piece, with seven postulated strong but short setae and four delicate, fine and long setae disposed of as shown in the figure.

MATERIAL EXAMINED : HOLOTYPE (male), ALLOTYPE (female) and PARATYPES (males and females) found on *Philostomus afer* (Linnaeus) at Gorom, Rufisque, Senegal (26. VI. 1955), collected by Monsieur P. Morel.

REMARKS : It has been mentioned elsewhere (Ansari, 1956) that close similarity of appearance in species of *Bruelia* is not an absolute guarantee of specific identity. Critical examination of all the salient characters is

therefore an important procedure to split similar forms. In general body form, especially in the shape of the head *B. moreli* sp. nov. resembles *B. zavattariornis* Ansari from *Zavattariornis stresemanni* Moloni and *B. deficiens* (Piaget) from *Cyanopica cyanus cooki* Bonaparte. From the two allied forms, it may be distinguished by the abdominal chaetotaxy and male genitalia.

The females of these three species are most difficult to distinguish from each other and warrant a general principle of discarding females for the purpose of relegating the specimens to the proper category. It may however be pointed out that the females are important tools for grouping similar forms and therefore need to be carefully described.

The species under discussion is also similar to *Bruelia zohrae* Ansari described recently from the same host [*Philostomus afer* (Linnaeus)] shot in Portuguese Guinea, from which it can be easily separated by its fircone shaped head (in the case of *B. zohrae* the head is acutely angulate in front), and dorsal abdominal chaetotaxy. The index of the hind head in *B. zohrae* is 1 : 2.15 while in the new species it is 1 : 1.579. The proportion of length and width in mesosomal plate is also very different in the two species.

This species is named after Monsieur P. Morel, the collector of this interesting species.

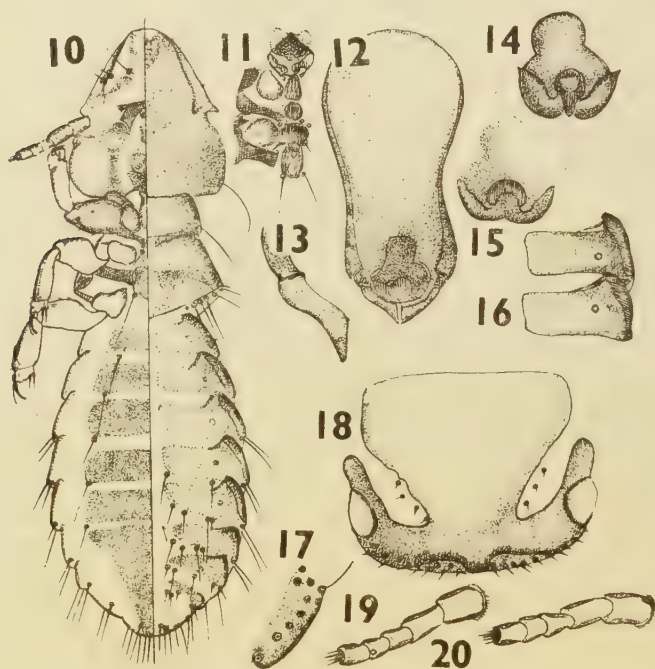
***Bruelia elbeli* sp. nov.**

(Text-figs. 10-20)

TYPE-HOST : *Gracula religiosa intermedia*.

HOLOTYPE (MALE) : 1.316 × 0.436 mm., delicate species with fairly well developed and slightly sclerotised tergal, sternal and pleural plates. Marginal carinae well formed. Head triangular with rounded frontal margin, 0.373 × 0.343 mm., cephalic index 1 : 0.919. Clypeal region with straight or slightly convex sides, sloped to an obtuse angle. Marginal carina well developed, heavily sclerotised proximally, unusual in other allied forms, the proximal head abruptly tapering, interrupted anteriorly, margin at this point hyaline. Preantennary area 0.189 × 0.272 mm., index 1 : 1.439. Antennae simple, showing slight sexual dimorphism. Hind-head 0.184 × 0.343 mm., index 1 : 1.864. Temples rounded towards the posterior angle, Preocular nodus and post ocular nodus although well developed, are short and narrow. Marginal temporal carina not distinct, very narrow. Posterior margin straight. The number and arrangement of cephalic setae as shown by Clay (1950). Eyes very small and narrow.

Prothorax 0.066×0.225 mm., frontal margin is very slightly extending under occiput. Pterothorax 0.164×0.318 mm., trapezoidal, side



Text-figs. 10-20. *Bruelia elbeli* sp. nov. (10) Dorsal and ventral aspects of male, (11) thoracic sternites, (12) male genital armature, (13) paramere, (14-15) two aspects of mesosomal plate, (16) V-VI targal plates of female, (17) ventral view of IX pleural plate showing arrangement of setae, (18) subgenital plate of female showing marginal chaetotaxy, (19) male antenna, (20) female antenna.

straight and slightly divergent, latero-posterior angle rounded, set with a slender spine and a long seta. Posterior margin convex with five submarginal setae beset at subequal distances. Legs as in the other species.

Abdomen 0.754×0.436 mm., ovate. Pleural plates II-IX well developed, II-III bare, IV-VII and IX with one dorsal and a similar ventral seta, VIII with one dorsal and two ventral setae, IX with one dorsal and a ventral seta, X+XI with 2+3+1 setae on each side. Tergal plates II-IX well formed, II-VII quadrate, VIII and IX triangular, III-VIII with spiracles, II-IV bare, V with one post-spiracular and one tergo-central, VI-VII with two post-spiracular and two tergo-central setae, VIII with one lateral

and three setae along the posterior margin, IX with one lateral and three setae near tergo-central area. Sternal plates well developed, II-VI quadrate, each with a seta in latero-posterior angle.

Male genitalia 0.2143 mm., long, well developed. Basal plate 0.1603 mm. long, anterior portion (0.1016 mm.) comparatively wider than posterior margin (0.0826 mm.). Parameres delicate structures, short and slender with simple proximal heads 0.0318 mm., long. Mesosomal plate 0.0461×0.0444 mm., of the pattern shown in the figure.

ALLOTYPE (FEMALE): The females are similar to the male but differs in measurements and abdominal chaetotaxy, 1.671×0.503 mm. Head 0.421×0.395 mm., cephalic index 1 : 0.938. Preantennary area 0.205×0.272 mm., index 1 : 1.265. Hind-head 0.205×0.395 mm., index 1 : 1.927.

TABLE I. MEASUREMENTS (IN MILLIMETERS) OF *Bruelia moreli* AND *B. elbeli*

<i>Bruelia moreli</i>			<i>Bruelia elbeli</i>		
	male	female	male	female	
Total	1.371 × 0.379	1.811 × 0.472	1.316 × 0.436	1.671 × 0.503	
Head	0.348 × 0.267	0.394 × 0.272	0.373 × 0.343	0.421 × 0.395	
Cephalic index	1 : 0.767	1 : 0.691	1 : 0.919	1 : 0.938	
Preantennary	0.179 × 0.225	0.205 × 0.255	0.189 × 0.272	0.215 × 0.272	
P. index	1 : 1.257	1 : 1.244	1 : 1.439	1 : 1.265	
Hind-head	0.169 × 0.267	0.189 × 0.272	0.184 × 0.243	0.205 × 0.395	
H. index	1 : 1.579	1 : 1.439	1 : 1.954	1 : 1.927	
Prothorax	0.098 × 0.205	0.098 × 0.231	0.066 × 0.225	0.103 × 0.255	
Pterothorax	0.138 × 0.267	0.169 × 0.277	0.164 × 0.318	0.169 × 0.369	
Abdomen	0.836 × 0.379	1.189 × 0.472	0.754 × 0.436	1.029 × 0.503	
Male genitalia					
total length	0.2302	... ..	0.2143	... ..	
Basal plate					
(length)	0.1682	... ..	0.1603	... ..	
anterior width	0.0857	... ..	0.1016	... ..	
posterior width	0.0651	... ..	0.0826	... ..	
Mesomal plate :					
length	0.0476	... ..	0.0461	... ..	
greatest width	0.0397	... ..	0.0444	... ..	
Parameres					
straight length	0.0539	... ..	0.0318	... ..	
oblique length	0.0635	... ..	...	...	
Type-host : <i>Philostomus afer</i> (Linn.)			<i>Gracula religiosa intermedia</i>		

TABLE II. CHAETOTAXY OF *Bruelia moreli* AND *B. elbeli*

MALE (HOLOTYPE)	<i>Bruelia moreli</i>			<i>Bruelia elbeli</i>		
	Tergal	Ventral	Pleural	Tergal	Ventral	Pleural
Pterothorax	5+5	1+1	1+1+1+1	5+5	1+1	1+1+1+1
Abdomen II	...	1+1	...	...	1+1	...
III	...	1+1	...	...	1+1	...
IV	1+1+1+1	1+1	-	...	1+1	1+1+1+1
V	1+1+1+1	1+1	1+1+1+1	1+1+1+1	1+1	1+1+1+1
VI	2+1+1+2	1+1	1+1+1+1	2+1+1+2	1+1	1+1+1+1
VII	2+4+4+2	...	-	2+2+2+2	...	1+1+1+1
VIII	2+3+3+2	...	2+2	1+1+1+1	...	3+3
IX	3+3	...	1+1+1+1	1+3+3+1	...	1+1
X+XI	3+2	...	4+3+4	3+3	...	2+4+2+4
FEMALE (ALLOTYPE)	<i>Bruelia moreli</i>			<i>Bruelia elbeli</i>		
	Tergal	Ventral	Pleural	Tergal	Ventral	Pleural
Pterothorax	5+5	1+1	1+1+1+1	5+5	1+1	1+1+1+1
Abdomen II	...	1+1	...	...	1+1	...
III	...	1+1	...	...	1+1	-
IV	...	1+1	-	...	1+1	1+1+1+1
V	...	1+1	1+1+1+1	...	1+1	1+1+1+1
VI	1	1+1	1+1+1+1	1	1+1	1+1+1+1
VII	1	...	1+1+1+1	1	...	1+1+1+1
VIII	2+2+2+2	...	3+3	1	...	1+1+1+1
IX	-3+3-	...	1+5+5+1	2+1+1+2	...	1+1+1+1
Vulva	...	7+4+4+7	...	...	9+4+4+9	...

Prothorax 0.103×0.255 mm., latero-posterior angle with a seta. Pterothorax 0.169×0.369 mm., with five submarginal setae, and a spine and a seta in the latero-posterior angle. Sternites with one seta on each side. Abdomen 1.029×0.503 mm. Tergal plates II-IX well developed, II-VIII interrupted in the middle, IX entire, II-V bare, VI-VIII with one post-spiracular seta, IX with two short and a long seta on each side of the middle line. Pleural plate II-IX well developed, II bare, III with one, IV-VIII with one dorsal and a ventral seta, IX with one antero dorsal and nine or ten ventral setae disposed of as shown in the figure. Sternal plates II-VI well developed, each with a seta in the latero-posterior angle as in the male. Subgenital plate squat, very typical, not so far seen in the species occurring on this group of birds, posterior cross piece almost straight, with lateral portion abruptly bent up, posterior margin beset with a row of nine strong and short setae and four fine setae as shown in the figure. VIII segment with a group of nine or ten setae on the latero-ventral aspect as shown in the figure.

MATERIAL EXAMINED : HOLOTYPE (male) ALLOTYPE (female) and PARATYPES (males and females) found on *Gracula religiosa intermedia* (Slide lot No. 2755) at Kamphaeng Phet, Khanu, Salak Bat, Ban Thung Chauk on 25. VI. 1953, collected by Mr Robert E. Elbel. One male and a female from *Gracula religiosa* Linn. (RE 2324) Chlang Rai, Chiang Saen Kao (Thailand), 24. II. 1953, collected by Elbel and Deigran. Several males and females (in spirit) from the same host, Chaiyaphum, Bhukao, Bon Mon Taslek, (Thailand), 14. XII. 1952, RE 901, RTB 175337, Collected by Mr R. E. Elbel.

REMARKS : *Bruelia acutangulata* (Piaget) and *B. nigrosignata* (Piaget) are said to come from *Gracula religiosa religiosa* Linnaeus (Hopkins & Clay, 1952). Clay informs me that these specimens do not resemble these two species. The specimens under study resemble *Bruelia longipes* (Piaget) from which it differs in the shape of the head and details of male genitalia.

This species is named after Mr Robert E. Elbel, the collector of these interesting specimens from *Gracula religiosa intermedia*.

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Ueber eine Phacidiaceae auf *Quercus*.

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Chona, Munjal und Kapoor (1957) beschrieben einen auf den Blättern von *Quercus incana* Roxb. parasitierenden Ascomyceten und stellten diesen als *Cryptomyces quercus* in die Gattung *Cryptomyces* Grev. Die Autoren gaben von diesem Pilz auch eine gute Schnittabbildung. Es unterliegt darnach keinem Zweifel, dass es sich dabei um den Pilz handelt, welchen wir ebenfalls erst kürzlich als *Neophacidium quercus* neu beschrieben haben (Müller und Ahmad, 1957). Nach Vergleich unseres Originalmaterials mit Herbarmaterial handelt es sich beim Wirt unseres Fundes ebenfalls um *Quercus incana* Roxb. Die Priorität in der Beschreibung kommt aber offensichtlich den erstgenannten Autoren zu.

In beiden Beschreibungen wird der Pilz als Vertreter der Phacidiales aufgefasst, aber es bleibt eine Differenz in der Gattungszuteilung. Die Phacidiales lassen sich nach von Arx und Müller (1954) in drei Familien gliedern: Phacidiaceae, Cryptomycetaceae und Hypodermataceae. Die beiden erstgenannten Familien besitzen einzellige, mehr oder weniger ellipsoidische oder breit spindelige Sporen ohne Schleimhülle, während sich die Hypodermataceae durch verlängerte Sporen mit Schleimhülle auszeichnen. Die Familie der Cryptomycetaceae umfasst nach von Arx und Müller (1954) zwei Gattungen *Phacidiella*, *Potebnia* und *Cryptomyces* Grev., welche beide vorderhand monotypisch sind und sich durch krustenförmige, innen helle, fleischig-gelatinöse, aus farblosen Hyphen aufgebaute Stromata auszeichnen. Die Phacidiaceae besitzen kein Stroma oder falls ein solches vorhanden ist, ist es dunkel und auf keinen Fall fleischighyphig aufgebaut.

Die Gattung *Cryptomyces* Grev. im Sinne von Saccardo (Sylloge Fungorum) ist heterogen. Zur Beurteilung der Gattung kann nur auf den Typus gegriffen werden, den wir (von Arx und Müller, 1954) erst kürzlich abgebildet haben. Der Pilz auf *Quercus* besitzt nun aber überhaupt kein Stroma und ist von *Cryptomyces maximus* (Fr.) Rehm deutlich verschieden.

Wir haben den Pilz nochmals mit *Neophacidium macrocarpum* (Pat.) Petr. verglichen und wiederum eine deutliche Uebereinstimmung gefunden. Darnach muss der Pilz heissen :

Neophacidium quercus (Chona, Munjal et Kapoor) comb. nov.
Synonyme: *Cryptomyces quercus* Chona, Munjal et Kapoor - Indian Phytopathology 9, 126 (1956) (ausgegeben 1957).

Neophacidium quercus Müller et Ahmad - Biologia 3, 16 (1957)
Matrix: auf lebenden Blättern von *Quercus incana* Roxb. (Himalaya).

L I T E R A T U R

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Chona, B.L., Munjal, R.L. und Kapoor, J.N. 1956 - Indian Phytopath. **9**: 126 (ausgegeben 1957).
Müller, E. und Ahmad, S. 1957 - Biologia, Lahore. **3** (1): 1-18.

Rust on *Digitaria adscendens*

ABDUL HAFIZ,* S.F. HASSAN & KHURSHEED AKBER **

In May 1956 and January 1957 *Digitaria* sp. growing as a weed in a cultivated field at Malir, Karachi, was found severely rusted. The host was identified as *Digitaria adscendens* (H.B.K.) Henrard and the pathogen as a species of *Puccinia*.

Puccinia oahuensis E. & E. has been reported from China on *Digitaria* sp. (Mycologia 43: 1: 94: 1951), but the *Puccinia* sp. under reference differs from *P. oahuensis* in having scattered germ-pores in the uredospores.

According to Deighton of Commonwealth Mycological Institute, Kew, to whom the specimen was referred, this rust is close to *Puccinia digitariae v. lutinae* Viennot-Bourgin which is known only from the type collection from Ivory coast and there is one collection in the C.M.I., Kew, from Uganda on *Digitaria scalarum* (= *D. vestita* var. *scalarum*) which is regarded as probably this species. However, the specimen under study differs from *P. digitariae-velutinae* only in having less well-developed paraphyses in the uredosori and both uredospores and teliospores running to a little larger size. Unless these differences are proved to be constant from the study of more collections it is desirable to name it as *Puccinia digitariae-velutinae* Viennot-Bourgin.

The fungus is the first record for Indo-Pakistan Sub-continent. The description of the fungus is as follows :-

UREDIA cauli-follicolous, when follicole amphigenous, often coalesced, erumpent, brown; UREDOSPORES light brown, globose or subglobose, measuring 22.8 - 36.1 x 19.0 - 28.5, u with an average of 29.3 x 25.0 u; paraphyses present; TELIA similar but fuscate; TELIOSPORES brown, clavate, distal end mostly obtuse, also rounded, apex thickened 3-7 u, constricted at the septum, measuring 34.2 - 64.6 x 15.2 - 32.3 u with an average of 45.9 x 24.2 u.; PEDICEL hyaline.

The specimens have been deposited at Central Mycological Herbarium, Department of Plant Protection, Karachi, Acc. No. 3765

* Food and Agriculture Council, Pakistan, Karachi.

** Department of Plant Protection, Karachi.

and at Herbarium Commonwealth Mycological Institute, Kew, I.M.I. No. 68390.

Authors are indebted to Mr Azmatullah Khan of the University of Karachi for valuable suggestions and to Director and Mr F.C. Deighton of Commonwealth Mycological Institute, Kew, for the assistance rendered during the course of this work.

On the respiratory system of the mastigure,

Uromastix hardwickii Gray

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The common spiny-tailed lizard, *Uromastix hardwickii* Gray, has been studied by the undergraduate students in these laboratories for over half a century now, but surprisingly enough, no authentic and detailed account of its anatomy was available till recently with the exception of Thapar's (1923) and Bhatia's (1929 a, b) studies on its vascular system. This gap has been filled to some extent by the work of Agrawal (1954) on sexual dimorphism, Saksena (1942) and Islam (1955, '56) on the skeleton, and Raza (1957) on the external morphology of the brain. The present paper, dealing with the anatomy of the respiratory tract, is an attempt in the same direction.

MATERIAL AND TECHNIQUE

Respiratory organs of adult specimens and a few mid-term and full-term embryos of *Uromastix hardwickii* were studied. The embryos, which had variously been fixed in Bouin's fluid, Kleinenberg's picrosulphuric acid, 5% formaline or rectified spirit, had all been stored in a mixture of alcohol and glycerine. The adult specimens had been stored in formaline. The skeleton of larynx, trachea and bronchi was studied in whole mounts stained with Victoria Blue and cleared in Xylol or Benzol. Transverse sections of the larynx were also cut and were stained with haematoxylin and eosin or borax carmine. The structure of the lungs was studied in transverse and longitudinal sections as well as in whole mounts of small pieces of lung stained with borax carmine. For studying the relations of the peritoneum, thick hand-cut sections of adult specimens and careful dissections from the ventral and right sides were used.

THE RESPIRATORY SYSTEM

TOPOGRAPHY. The glottis is an elongated, longitudinal, slit-like aperture situated at the anterior end of the larynx and leading into the trachea or wind pipe. The larynx (fig. I, *L.*), which may be regarded as the anterior dilated portion of the trachea (*T.*), lies on the floor of the pharynx, in the angle between the posterior horns of the tongue, though

at a slightly lower level than the latter. Thus, it stands safely out of the way of the morsel of food which the lizard may be swallowing.

The trachea, which lies still more ventrally, makes a small angle with the larynx, and runs backwards ventral to the oesophagus. On entering the thorax, it comes to lie dorsal to the heart (*H.*) where it bifurcates into two small bronchi. Sheets of connective tissue bind the trachea to the oesophagus above and the muscles of the neck at the sides.

The lungs (*LG.*) are saccular structures lying along the dorsal bodywall in the region of the thorax. In the ventral view, the anterior part of the lungs is covered over by the heart, and the posterior part by the liver (*LV.*).

PERITONEAL FOLDS. The disposition of the peritoneal folds in *Uromastix* and some other reptiles was studied in some detail by Butler (1889), and the present studies have confirmed his findings in almost every detail. The condition in the Indian house-gecko, *Hemidactylus flaviviridis*, is not very different (Mahendra, 1947).

The right lung (fig. II, *LG.*) is attached dorsally to the oesophagus by the dorsal pulmonary fold, while its root is attached to the pericardium. A ventral pulmonary fold attaches the ventral border of the lung throughout its length to the right lobe of the liver. This fold of peritoneum has been given the name of pulmohepatic ligament by Butler (1889). A strong fold of peritoneum attaches the tip of the right lung to the caecum. The space enclosed between the lung, liver and oesophagus is known as the pulmohepatic or pneumato-enteric recess. It ends blindly in front, but opens behind into the general body cavity.

The left lung, on the other hand, is attached to the oesophagus above and the pericardium anteriorly, but in most of the specimens studied its ventral border and tip are quite free. In one specimen, however, the left lung had the same attachments as the right one. Fig. II is a diagrammatic representation of the peritoneal folds of *Uromastix hardwickii* in the region of the lungs.

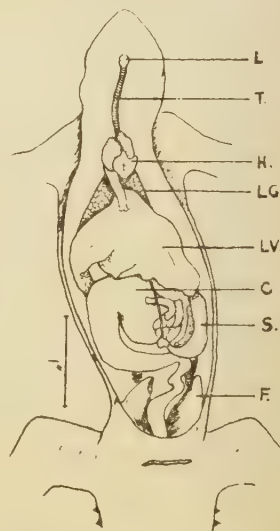


Fig. I. *Uromastix hardwickii* dissected from the ventral side to show the disposition of the viscera.

C. caecum; F. fat-body; H. heart; L. larynx; LG. left lung; LV. liver; S. stomach; T. trachea.

There is no transverse septum or partition separating the thorax (containing the lungs and encircled by ribs) from the abdomen. However, such a separation is functionally achieved, and, as will be described later, inspiration and expiration are achieved mainly by the movement of the ribs. The separation of the thorax and the abdomen is brought about in the same way as in *Hemidactylus flaviviridis* (Mahendra, 1947). The liver is large and its left lobe is concave on the posterodorsal side. Into this concavity fit the large caceum and ileum. The right lobe of the liver on one side and the stomach on the other, together with the apposition of the liver with the ventral bodywall, complete the separation of the thoracic region lodging the heart and the remaining viscera.



Fig. II. Disposition of the peritoneal folds.

LG, right lung; LV, liver; O, oesophagus.

It is interesting to note that in the adult the somatic layer of the peritoneum, which is black in the abdominal region, is completely unpigmented in the thoracic region. The entire peritoneum, however, is unpigmented in the embryonic condition.

THE LUNGS. Unlike *Hemidactylus flaviviridis* (Mahendra, 1947) and many other lizards, the two lungs of *Uromastix hardwickii* are usually unequal in size, the right lung being larger than the left. This is probably an adaptation to the changing volume of the stomach and the large size of the left lobe of the liver.

The bronchus enters a lung not at its anterior end but a little posteriorly on the mesial side. It goes into the lung for some distance, being embedded in the wall, but does not divide further. The point of entry of the bronchus (fig. III, BR.) into the lung makes it possible to distinguish two regions, viz., a short conical region anterior to the point of entry, and a long, broad, posterior region constituting by far the greater portion of the lung. This division is by no means arbitrary and superficial: a shelf-like septum (S.), formed by the intrapulmonary extension of the bronchus, separates the two regions internally also. This septum is present in the lungs of the full-term embryo, though not in the earlier stage examined.

The walls of the upper conical region are thick but not as vascular as the area below the septum. This can be judged by the relative closeness of the meshwork of capillaries in the latter region. It seems reasonable to conclude that very little respiratory exchange of gases takes place in

this region. Vascularization is at its maximum in the middle zone, but decreases gradually towards the posterior end of the lung.

The inner surface of the lungs is raised into a network of ridges formed mainly of muscular strands to which the lungs owe their elasticity. These ridges are of various types. Firstly, there are the stout ridges lying innermost and forming a network of broad meshes. Secondly, there are narrower ridges, and, thirdly, very delicate ridges. In the anterior conical region of the lung, stout muscular ridges are few. Most of the ridges in that region are very delicate and narrow, being less than one-fourth the diameter of the stout ridges which abound in the posterior part of the lung. In the conical region the network is closer and the meshes smaller than in any other part of the lung. In the middle region, where the vascularization is at the maximum, the stout muscular ridges are well-developed and form a fairly close network. In the posterior region of the lung the ridges are thick but the meshes are wide. This, however, is only the usual condition. In some cases there is an area of close network of muscular ridges at the posterior end. There may be a similar area in the middle region of the lung also.

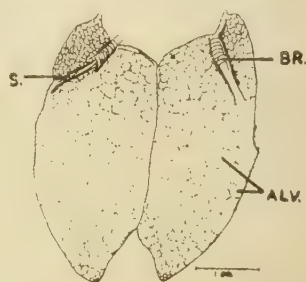


Fig. III. Left lung cut open.

ALV. alveoli; BR. bronchus;
S. septum.

The spaces enclosed by the network of muscular ridges are sometimes called alveoli (ALV.), though they do not correspond with the structures of the same name in the mammalian lung.

The full-term embryonic lung is very similar to the adult lung, but in the younger embryo the structure is very much simpler. In the latter, the lungs are simple hollow bags without any partition or shelf-like structure. The muscular strands have started making their appearance in the form of short low ridges. Very few of these ridges are long enough to cover half the circumference of the cylindrical lung. Trachea and bronchi are also absent as such.

HISTOLOGY OF THE LUNG. As mentioned above, the inner surface of the lung gives the appearance of a honeycomb because of the presence of a network of muscular strands. In a transverse section (fig. IV) the muscular strands (M.) appear as knob-shaped structures covered over by epithelium. The muscle fibres are unstriated and have oval nuclei very faintly stained with Delafield's haematoxylin. The shape of the knob depends of course,

on the angle at which the strand has been cut. The epithelial cells covering the 'knob' are usually rather loose and oval, with vesicular nuclei; but on some 'knobs', especially the large ones, there is a covering of ciliated epithelium.

The muscular strands, cut as knobs, are supported by a number of delicate but long strands or septa (S.), separating the adjacent alveoli from each other and serving to increase the inner surface of the lung. Each supporting strand usually consists of a very narrow central column of connective tissue covered on all sides by epithelial cells. In most cases there is a single layer of cells around the central connective tissue column. Sometimes a minute capillary runs through the strand.

The connective tissue fibres of the supporting strand are a part of a thick connective tissue sheath going round the whole lung. Externally, there is an extremely delicate serous membrane distinguishable mainly by its deeply stained spindle-shaped nuclei.

TRACHEA AND BRONCHI. The trachea is a long tube supported by rings of cartilage (figs. V & VI). The rings are usually irregular in outline and frequently bifurcate or put out branches to become connected to adjacent rings. This character of the trachea is shared by the bronchi also, and is probably common in lizards. It is usually not possible in

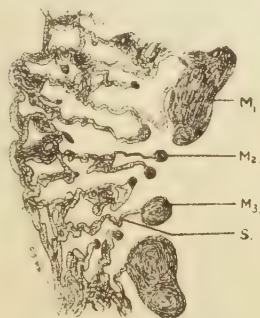


Fig. IV. T. S. lung (low magnification)

M1, M2, M3: muscular ridges of various sizes; S: septum.



Fig. V (On the left) Trachea and bronchi, ventral view; Fig. VI dorsal view.

Uromastix to count the tracheal or bronchial rings precisely because of their asymmetrical and irregular branching. Moreover, unlike *Hemidactylus garnoti* (Steck, 1908) and some other lizards, the trachea of *Uromastix hardwickii* cannot be divided into regions with complete and incomplete rings.

As a result of the frequent presence of the connexions between adjacent rings, almost the whole of the trachea and bronchi are rather stiff and uncollapsible. This is probably advantageous for the lizard which has to swallow its food unmasticated, as a large bolus. In birds it is necessary to have the rings separate, because a long mobile neck must have a trachea which can bend easily. There is no such consideration in lizards like *Uromastix* which do not have a long and flexible neck.

THE LARYNX. As mentioned already, the larynx (fig. VII) is a globular structure lying at the base of the tongue. Its skeleton has been studied in whole mounts, in transverse sections and in the stained preparations of larynx dissected with fine needles.

As in other lizards, the larynx of *Uromastix hardwickii* is supported by a pair of arytenoids (A.), and a large shield-shaped cricoid (C.). There are no rudiments of the thyroid cartilage as are found in some chameleons and other lizards (Negus, 1929). In snakes the cartilage corresponding to the cricoid of *Uromastix* is sometimes referred to as crico-thyroid cartilage, but such a nomenclature remains to be justified.

The arytenoids are small, broadly conical and slightly curved cartilages articulating in two concavities at the anterior dorsal end of the cricoid. Ventrally, they are supported by a narrow median process of the cricoid. The lateral and dorsal sides of each arytenoid are concave, the posterior side is convex, while the medial and ventral side are more or less straight. A prominent muscle,

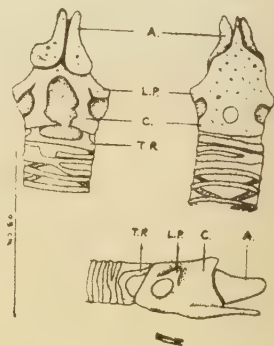


Fig. VII. Larynx and anterior rings of the trachea. Top left: dorsal view; top right ventral view; bottom: lateral view.

A, arytenoid; C, cricoid; T R, first tracheal ring.

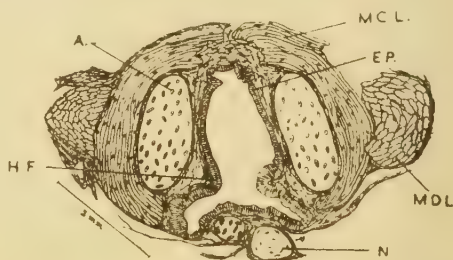


Fig. VIII. Transverse section of larynx through the arytenoids, a little behind the glottis.

A, arytenoid; EP, epithelium; H.F. horizontal fold; MCL, musculus compressor laryngis; MDL, musculus dilator laryngis; N, nerve.

which may be called the *musculus dilatator laryngis* or *lateral crico-arytenoid* (figs. VIII-X, MDL.) arises from the lateral process of the cricoid (fig. VII, L.P.) and is inserted at the anterior tip of the arytenoid of its side. This muscle serves as the dilatator of the glottis. The tips of the two arytenoids are bound together by a pair of muscles which probably represent the *musculus compressor laryngis* or *transverse arytenoid* (figs. VIII-X, MCL.).

The cricoid (fig. VII, C.) is a large and broad cartilage which forms the floor and side-walls of the laryngeal cavity. It is incomplete dorsally except for a narrow band at the anterior end, but ventrally it is complete except for a narrow hole in the posterior region. This foramen is covered over by a membrane. At the same level, there is a foramen in each ventrolateral wall of the cricoid also. These foramina can be construed as dividing the cricoid incompletely into a much wider ring anteriorly and a narrower ring posteriorly. The only merit of such a construction, however, is that it brings the cricoid of *Uromastix hardwickii* into line with forms like *Hemidactylus* where the cricoid is formed of two rings. Anteroventrally, the cricoid is produced into a long, narrow process extending below and in between the two arytenoids. Posteriorly, just dorsal to each ventrolateral foramen, the cricoid is produced into a short, blunt, lateral process (fig. VII, L.P.). The lateral crico-arytenoid muscle arises from this process.

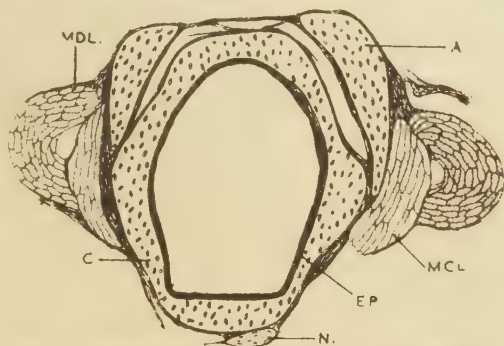


Fig. IX. Transverse section of the larynx through the anterior part of the cricoid.

A. arytenoid; C. cricoid; EP. epithelium; MCL. *musculus compressor laryngis*; MDL. *musculus dilatator laryngis*; N. nerve.

The first tracheal ring (T.R.) is closely associated with the cricoid and lends support to the now established view that the cricoid is a derivative of the anterior tracheal cartilages.

The larynx is lined by a simple ciliated epithelium (figs. VIII-X, EP.) supported by a thin layer of connective tissue. Interspersed in the epithelium are a large number of unicellular mucous cells. The mucous cells are particularly numerous in the floor and side-walls of the anterior part of the larynx. In the region of the cricoid (fig. X) the connective

tissue supporting the lining epithelium is particularly thin and loose, and the latter hangs into the cavity of the larynx between its dorsal and ventral walls. Structures like this have been described by workers on the Gekkonidae as vocal cords, but in the present case it is doubtful if the above-mentioned folds of epithelium produce any vibrations.

The anterior part of the laryngeal cavity, in the region of the glottis, shows a structure very similar to what Mahendra (1947) has described as vocal cords in *Hemidactylus flaviviridis*. These are prominent horizontal folds of the lining epithelium, lying on the lower part of the lateral walls (fig. VIII, *H.F.*). Since *Uromastix hardwickii* is not known to make any audible sounds, it is difficult to designate these folds as vocal cords.

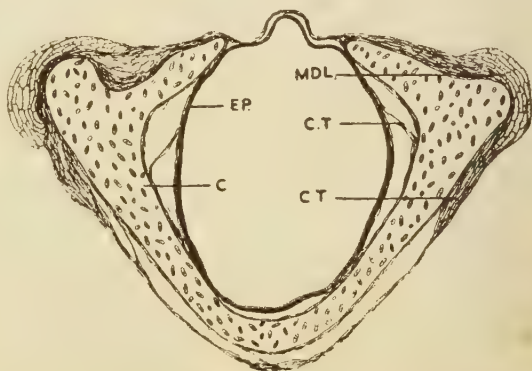


Fig. X. Transverse section of the larynx through the posterior part of the cricoid.

C. cricoid; C.T. connective tissue; EP. epithelium; MDL. musculus dilatator laryngis.

Negus (1929) has studied the mechanism of breathing of a large number of animals including *Uromastix hardwickii*. He has found that in this lizard, as in *Sphenodon* or *Physignathus lesueuri*, breathing is accomplished only by the movement of the ribs, whereas in *Varanus varius* and many other lizards the raising and lowering of the floor of the buccal cavity plays an important part in breathing. In *Uromastix* the floor of the buccal cavity is too rigid and tightly stretched to be of much use in this way. Detailed studies on the mechanism of respiration in this lizard have also been made by Boelaert (1936). The pharynx and oesophagus of *Uromastix* are not unusually vascular, and in this case there is little possibility of these organs performing a respiratory function as they do in *Trachysaurus rugosus* and some other lizards (Drummond, 1946).

SUMMARY

The respiratory tract of the mastigure, *Uromastix hardwickii* has been described in detail. The right lung is larger than the left, and each lung is incompletely divided into two unequal regions by an intrapulmonary extension of the bronchus. All parts of the lung are not equally vascular :

the anterior and posterior regions being less vascular than the middle region. The inner lining is raised into a network of ridges. Part of the lining epithelium is ciliated.

The topographical relations of the lungs, especially the disposition of peritoneum connected with them, have been described in detail.

The trachea and the bronchi are supported by irregularly branching and anastomosing cartilaginous rings many of which are incomplete.

The larynx is supported by two arytenoids and a large shield-shaped cricoid, the latter with a median anterior ventral process and one lateral process on either side. The origin and insertion of the laryngeal muscles and the structure and disposition of the epithelium lining the larynx have been described.

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A short note on the morphology of cercaria of *Fasciola gigantica*, with a discussion on the composition of different larval forms of the fluke occurring in *Limnaea rufescens*.

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The observations recorded in this paper are based on a study of the larval forms obtained from the snail *Limnaea rufescens*. All such snails were collected from localities which are essentially identical in topography and are situated in the highlands of Rawalpindi and Jhelum districts. The morphology of the cercaria was studied from both fresh and stained specimens.

MORPHOLOGY OF CERCARIA

The body of the cercaria is circular or suboval in outline and measures 0.25 - 0.3 mm. in length and 0.175 - 0.225 mm. in breadth when at rest. If stretched, it measures 0.4 mm. long and 0.15 mm. broad, but, if contracted, 0.165 mm. long and 0.3 mm. broad. The tail, in the living specimens, measures 0.62 mm. in length when contracted and 0.9 mm. long when stretched. It is simple and there are no pockets at the site of its attachment to the body. The suckers are subequal and measure about 0.075 mm. in diameter. The gut shows a well marked pharynx which is 0.04 mm. long and 0.03 mm. broad. The oesophagus and the branches of the gut are difficult to make out. The body of the cercaria is covered with minute spines. The cystogenous cells, containing large granules, occupy most of the surface of the body and are arranged mainly in two large lateral masses. Two other groups of cystogenous cells which are smaller in number and size, are found to lie, respectively, anterior and posterior to the ventral sucker in its close proximity. The cells stain yellow with Acetic Carmine.

The excretory system consists of an excretory vesicle situated posterior to the ventral sucker, in the mid-line. The lateral vessels of the excretory system are first visible near the pharynx and they seem to meet in the mid-line. The vessels diverge as they run back until the level of the anterior edge of the ventral sucker where they bend inwards and pass

on each side over the lateral edge of the sucker. Posterior to the sucker they converge to enter the vesicle at its anterior end. The lumen of each excretory vessel contains spherical, highly refractive bodies which measure, at the anterior end, 1-2 μ in diameter, but for the greater length of the vessels, they measure about 8-12 μ in diameter. Posterior to the ventral sucker, the bodies become smaller in size and they finally disappear. It is difficult to distinguish the portion to the excretory vessel near its junction with the vesicle.

The location of the genital primordial cells depends on the state of contraction of the cercaria and they may lie half way between the ventral sucker and the posterior margin of the body, but, in contracted specimens, they may be situated dorsal of the ventral sucker.

COMPOSITION OF LARVAL FORMS IN THE INFESTED SNAILS

Leuckart (1886), who worked out the life cycle of *Fasciola hepatica* in Germany, maintained that there are two distinct kinds of rediae in the life cycle of *F. hepatica* and the appearance of these forms in the snails is

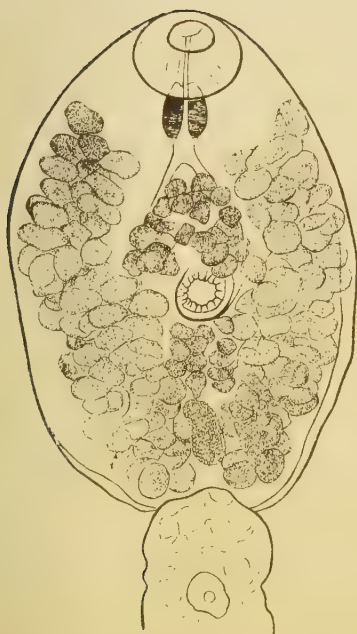
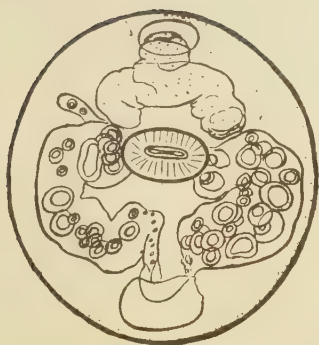
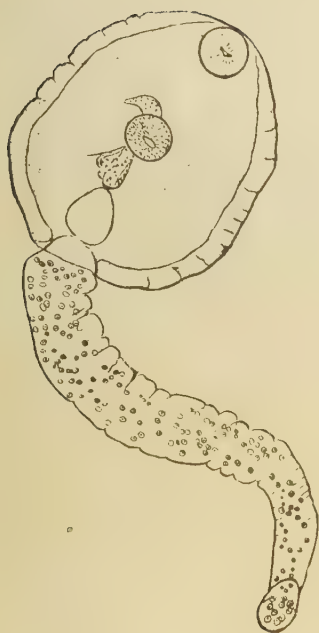
The following data, revealing the composition of larval forms in *L. rufescens*, was obtained on dissection of snails at the commencement of October :

Serial No. of Snail.	Height of shell of the snail.	Number of rediae.	Number of liberated cercariae.	Range of length of rediae.	Contents of rediae.		
					No. of mature cercariae.	No. of embryo balls.	No. of daughter rediae.
1.	22	93	—	Younger 0.95-1.2 Older 2-2.8	— 8-12	10-13 3-6	— —
2.	20	212	175	Younger 0.35-1.6 Older 1.2-2.7	— 2-12	4-25 3-10	— —
3.	22	126	400-500	Younger 0.7-1.4 Older 2-2.2	— 4-12	4-10 3-5	— —
4.	22	18	—	Younger 1.55-2.2 Older 1.8-2.7	— 5-14	11-13 4-5	— —
5.	22	34	—	Younger 0.375-1.3 Older 1.5-1.8	— 1 (one) Immature cercaria.	5-21 8-22	— 3-11

(All measurements in millimetres)

Snail No. 4 contained 5 older and 13 younger rediae.

Snail No. 5 contained 4 older and 30 younger rediae.



Top left: Cercaria of *F. gigantica* (x 190); Top right: A cyst of cercaria after the tail of

subject to the season of the year. He stated that when a snail contracted infection in autumn, the rediae developing from the sporocyst produced only daughter rediae, and these, in turn, gave rise to cercariae in the following spring. Again, if the snail got infected in spring, all the rediae which developed from the sporocyst, directly started the production of cercariae in the summer. On the other hand, Thomas (1883) who had worked in England maintained that daughter rediae were produced in summer but cercariae were produced directly by the rediae which had developed from the sporocyst in cold months.

Evidence has been brought forth, in the following lines, to show that different seasons of the year bear no relationship to the production, by the rediae, of daughter rediae or cercariae. It would appear from the data that the composition of different larval forms could be accounted for in the light of age of the infestation of snail.

In the above table the composition of the larval forms in the first and fourth snail is different from that of second and third and the composition in that of the fifth is different from any of the two categories.

In a batch of 11 snails examined in the middle of October, the composition of the larval forms was found to be as follows :

Serial No. of snail.	Total number of rediae recovered.	Total number of liberat- ed cercariae recovered.
1.	6	—
2.	43	9
3.	21	—
4.	11	8
5.	5	—
6.	14	—
7.	110	—
8.	168	29
9.	17	—
10.	5	—
11.	129	—

In snail No. 11, the majority of rediae contained cercariae and embryo balls but some rediae contained daughter rediae as well.

In snail No. 8 all the rediae contained cercariae and embryo balls only.

During November, a snail with the shell measuring 11 mm. high, harboured one older and two younger rediae only. The older rediae contained about 32 developing rediae. In four other examples with shells

measuring between 25 and 33 mm. there were, respectively, 308, 384, over 700 and 926 rediae generally containing cercariae and embryo balls or embryo balls only. All the four examples contained liberated cercariae as well but these were not counted.

During February, eight examples showed the following composition :

Serial Number of snail.	Number of rediae containing cercariae.	Number of rediae containing daughter rediae
1.	46	18
2.	124	35
3.	115	15
4.	42	—
5.	110	—
6.	86	19
7.	53	—
8.	45	—

The number of cercariae inside the rediae was found to be comparatively small. Some rediae contained only one cercaria, each. Some of the mother rediae, likewise, contained one daughter redia, each.

During March one 18 mm. high shell was found to harbour 43 older rediae containing cercariae and embryo balls and 39 younger rediae and 153 liberated cercariae. Another example was found to harbour 23 rediae, one of the rediae containing daughter rediae and the rest containing cercariae and embryo balls. There were, however, no liberated cercariae in this snail. Yet another 20 mm. high shell example was found to contain 4 older and 13 younger and a number of smaller rediae of varying sizes which were not counted. The older rediae contained daughter rediae as well as cercariae, while, the younger contained embryo balls.

A large specimen with the shell measuring 30 mm. high, harboured 643 rediae and 1,400 liberated cercariae.

In an example measuring 22 mm. high shell, six of the rediae examined showed the following contents :—

Sr. No. of redia.	No. of mature cercariae.	No. of immature cercariae.	No. of embryo balls.
1.	7	1	1
2.	9	3	4
3.	8	5	—
4.	5	3	6
5.	—	2	13
6.	16	3	5

In one of the younger generation redia measuring 2.2 mm. in length there were 31 embryo balls in different stages of development. In an older generation redia measuring 3 mm. long there were 9 fully developed cercariae and 27 embryo balls. A younger generation redia measuring 0.65 mm. long contained 10 embryo balls. The youngest redia was 0.29 mm. long and showed a maximum breadth of 0.12 mm.

During April, seven examples with shells measuring 20 to 28 mm. were found to harbour only rediae and there were no liberated cercariae. A majority of the rediae in all the seven examples contained daughter rediae while the rest contained cercariae and embryo balls. In an example with 29 mm. shell there were 402 rediae of different sizes and most of them contained cercariae and no daughter rediae. There were, however, no liberated cercariae in the snail. The cercariae contained in the rediae showed no activity.

The data presented in the paper would show that daughter rediae as well as cercariae occur in snails both during the warm and the cold months of the year and the form and intensity of infestation in the snail bore a direct relationship to the age of the snail, and which, in all probability, corresponded to the age of infestation.

The differences which may exist in the composition of larval forms to be found in *L. truncatula*, an intermediary of *F. hepatica*, and *L. rufescens*, an intermediary of *F. gigantica*, may be explained on grounds of differences that exist in the ecology of the two intermediaries. *L. rufescens*, an entirely aquatic snail, remains active throughout the year and occurs in localities which may have a rigorous winter but no snowfall.

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Quart. J. Micr. Sci. **23** : 99-133.

A preliminary guide to the identification of the males of *Bruelia* (Keler 1936 : Mallophaga) spp. infesting corvine birds.

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This paper is mainly a result of a study of 38 species of *Bruelia* from 48 species of crows, rooks and ravens in the collection of the British Museum (Natural History), London. The males have invariably been found to be the best guides to species, and therefore have been used exclusively in the preparation of the key given below. In some cases female characters have also been included in the key to provide further aid to the identification of the species. All such characters are given within brackets. Species not represented by males are not included in the key.

Throughout these studies, the shape of the head was found to be an important distinguishing feature. The cephalic index, the ratio of the length to the width of the preantennal region and post antennal region have therefore been used as reliable criteria for specific differentiation (Table I). The characters of preantennal region warrant careful consideration. According to the marginal carina alone, these species may be grouped into eight different categories. In some cases the relative development of basal antennal segment was found to be of considerable importance. The size and shape of the conus, (and probably the number of facets and the size of the individual facet in the eye) may in rare instances provide useful tools to separate subspecies. The form of the prothorax and pterothorax are most reliable features (and so are the dorsal setae) and should be carefully studied. The tergal plates and the dorsal abdominal chaetotaxy vary considerably, and are found useful in the initial grouping of allied forms (Tables II and III). The male genital armature is, in fact, the most important character for species identification. In general, most reliance is placed upon the paramere structure (the proximal head of parameres in particular), the shape of the endomeral plate and upon its structural details. The basal plate is usually of uniform pattern throughout the genus, its ratio with the total length of the armature, however, furnishes useful data for the identification of species (Figs. 1-21). The

subgenital plate and the vulval chaetotaxy in the female are of secondary importance and should be studied wherever possible.

TENTATIVE KEY TO THE MALES OF *BRUELIA* SPECIES
PARASITIC ON CROWS, ROOKS AND RAVENS

1. Parameres without well-developed proximal head, the hilt-like handle always wanting ... 2
Parameres with well-developed proximal head, modified more or less as a hilt or handle ... 14
2. Delicate species ; genital armature fragile ; abdominal chaetotaxy scarce ; tergites ii-iii without setae, 1v either bare or with 2-4, v with 2-4, vi with 6-8, vii with 8-12, viii with 8-10 fine setae. (In females, tergites ii-iv bare, v either bare or with 1+1, vi-vii with 1+1 setae) ... 3
Moderately built species ; genitalia well-built ; chaetotaxy moderate ; tergite ii with 4-8, iii with 8-12, 1v with 6-11, v-viii with 8-12 or 14 setae on each side. (In female, tergites ii-vii with 1+2-4+2-4+1 setae) ... 6
3. Ratio of length to width of the preantennal region (index) 1 : 1.25 ... 4
Ratio of length to width of the preantennal region (index) 1 : 1.34-1.52 ... 5
4. Head fircone-shaped ; preantennal index 1 : 1.26 ; hind-head index 1 : 1.58 ; cephalic index 1 : 0.77. (In female, cephalic index 1 : 1.58 ; cephalic index 1 : 0.69 ; preantennal index 1 : 1.24 ; hind-head index 1 : 1.44 ; viii tergite with 2+2+2+2 setae) ...
... *Bruelia moreli* Ansari (1957) ex *Ptilostomus afer* (L.)
Head acute in front ; preantennal index 1 : 1.24 ; hind head index 1 : 2.15 ; cephalic index 1 : 0.93. (In female, cephalic index 1 : 0.98 ; preantennal index 1 : 1.45 ; hind-head index 1 : 2.151 ; viii tergite with 1+1+1+1 setae). ...
... *Bruelia zohrae* Ansari (1956) ex *Ptilostomus afer*
5. Head narrow, preantennal index 1 : 1.74 ; cephalic index 1 : 0.8 ; parameres comparatively smaller ; hind-head smaller than preantennal region. (In female, viii tergite with 1+1+1+1, ix with 1+2+2+1 setae ; vulva with 9-10 setae on each side) ...
... *Bruelia zavattariornis* Ansari (1956) ex *Zavattariornis stressemanni* Moloni.
Head broad ; preantennal index 1 : 1.52 ; hind-head index 1 : 1.71 ; cephalic index 1 : 0.9 ; hind-head longer than preantennal region ;



Text fig. 1. Genital armature of *Bruelia dificiens* (Piaget) ex *Aphelocoma c. californica*. 2. mesosomal plate. 3. paramere without well developed hilt-like proximal head. 4. Genital armature of *Bruelia digitata* (Kellogg et Paine) ex *Parusdocos c. himalayanus*. 5. paramere with well developed proximal head but not midified into hilt. 6. mesosomal plate. 7. Genital armature of *Bruelia glandaria* (Denny) ex *Garrulus g. glandarius*. 8. mesosomal plate. 10. Genital armature of *Bruelia quadrangularis* (Rudow) ex *Corvus albus*. 11. two aspects of mesosome. 12. parameres with well developed hilt like proximal head. 13. Head of *Bruelia varia* (Burmeister) ex *Corvus freigilegus tschusii* with interrupted marginal carina. 14. Head of *Bruelia biguttata* (Kellogg et Paine) ex *Pyrrhocorax p. himalayanus* with entire marginal carina. 15. Head of *Bruelia argula* (Burmeister) ex *Corvus corax ruficollis* with well developed marginal carina hanging in the middle. 16. male genital armature of *Bruelia salmei mollis* Ansari ex *Corvus coronoides colomorum* showing slight sexual dimorphism. 17. female genital armature of *Bruelia salmei mollis* Ansari ex *Corvus coronoides colomorum* showing slight sexual dimorphism. 18. male genital armature of *Bruelia salmei mollis* Ansari ex *Corvus coronoides colomorum* showing slight sexual dimorphism. 19. female genital armature of *Bruelia salmei mollis* Ansari ex *Corvus coronoides colomorum* showing slight sexual dimorphism. 20. Portion of abdominal segment of *Bruelia salmei mollis* Ansari ex *Corvus coronoides colomorum* showing rectangular tergal plates. 21. Portion of abdominal segment of *Bruelia varia* (Burmeister) ex *Corvus corone corone* showing medially open tergal plates.

ABBREVIATIONS: CO: conus, MC: marginal carina continuous, MI: marginal carina hanging in the middle, MI: marginal carina interrupted, PH: proximal head, PS: post spiracular seta, TC: tergo-central seta, TL: tergo-lateral seta, VS: fifth antennal segment.

- parameres comparatively longer. (In female, tergite viii with 1+1, ix with 1+3+3+1 setae; vulva with 7-8 setae on each side)
Bruelia deficiens (Piaget 1885) ex *Cyanopica cyanus cooki* Bonaparte.
6. Hind-head index 1 : 2.01-2.09 7
 Hind-head index 1 : 1-62-1.87 8
7. Preantennal index 1 : 1.54 ; cephalic index 1 : 0.97 ; ix tergite with 8 setae.....*Bruelia koslovae* (Clay, 1936) ex *Podoces bidulphus* Hume
 Preantennal index 1 : 2.06 ; cephalic index 1 : 1.18 ; ix tergite with 13 setae *Bruelia multipunctata* (Clay, 1936) ex *Nucifraga caryocatactes multipunctata* Gould.
8. Preantennal index 1 : 1.9-2.0 9
 Preantennal index 1 : 1.77. (In female, tergites with 1+2-4+2-4+1 setae)
 ... *Bruelia atherae* Ansari (1957) ex *Corvus corax laurencei* Hume.
9. Tergite ix with 19-23 setae 10
 Tergite ix with 10-15 setae 12
10. Head as long as wide. (Vulva with 15-16 setae on each side)
 *Bruelia biguttata* (Kellog and Paine, 1914) ex *Pyrrhocorax graculus graculus* (Linn.)
 Head longer than wide 11
11. Hind-head index 1 : 1.6. (Vulva with 12 setae on each side)
 *Bruelia biguttata docilis* Ansari (1956) ex *Pyrrhocorax p. docilis* (Gmelin).
 Hind-head index 1 : 1.82. (Vulva with 17-18 setae on each side)
 ... *Bruelia biocellata* (Piaget, 1880) ex *Pica p. leucopters* Gould.
12. Tergites vii and viii with 1+5+5+1 setae. (In female, tergites iii-vi with 1+4-5+4-5+1 setae) 13
 Tergites vii-viii with 1+3+3+1 setae. (In female, ii-vi tergites with 1+2-3+2-3+1 setae)
 ... *Bruelia nawabi* Ansari (1957) ex *Corvus capensis* Licht.
13. Head longer than wide ; ix tergite with 5+3 setae on each side
 ... *Bruelia cryptoleucus* Ansari (1957) ex *Corvus cryptoleucus* Couch.
 Head wider than long ; ix tergite with 4-6+5-7 setae ... *Bruelia varia* (Burmeister, 1838) ex *Corvus monedula spermologus* Vieillot.
14. Tergites ii-iii with 0-4 setae 15
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15. Marginal carina interrupted at one or two points ... 16
 Marginal carina entire, either regularly sclerotized throughout or
 feebly sclerotized in the middle, marginal carina at this point may
 be hanging posteriorly 22
16. Tergites vi-viii with 3+2+2+3 and ix with 28 (3+11+12+3) setae
 *Bruelia*
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 Tergites vi-viii with 1-2+1+1+1-2, and ix with 12-16 (1-2+3-
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 ... *Bruelia hopkinsi* Ansari (1956) ex *Xanthura yncas galeata* Ridgway.
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18. Mesosomal plate more or less trapezoidal in form ... 19
 Mesosomal plate triangular in form
Bruelia clayae Ansari (1956) ex *Cyanocitta cristata cristata* (Linn.).
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 ... *Bruelia nitzsche* Keler (1938) ex *Cyanocorax cyanomelas* (Vieillot).
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 Anterior margin of the mesosomal plate about half of the greatest
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21. Proximal head of the paramere with comparatively broad hilt, total
 length of the paramere relatively short *Bruelia*
glandarii (Denny, 1842) ex *Garrulus glandarius rufitergum* Hartert.
 Proximal head of the paramere with comparatively narrow hilt, total
 length of the paramere relatively long ... *Bruelia glandarii*
perisorius Ansari (1956) ex *Perisorius infaustus infaustus* Linn.
22. Parameres long and broad, at least half as long as the total length of
 the genital armature 23
 Parameres short and narrow, one-fourth of the total length of the
 genital armature
 ... *Bruelia perwienae* Ansari (1957) ex *Corvus nasicus* Temminck.
23. Preantennal index 1 : 2.31-2.37 24
 Preantennal index 1 : 1.97-2.08 26

24. Tergal plates ii-viii rectangular or triangular; tergite ix with 20 (1+8-9+9+1) setae
Bruelia tasniemae Ansari (1957) ex *Corvus frugilegus frugilegus* (Linn.)
 Tergal plates ii-viii of the shape of 'sign of interrogation'; tergite ix with 26 (1+12+12+1) setae 25
25. Tergal plates well-pigmented near the stigmata, with a posterior pigmented arm forming a horizontally laid 'sign of interrogation'
Bruelia uncinosa (Burmeister, 1838) ex *Corvus corone cornix* Linn.
 Tergal plates well-pigmented near the stigmata, posterior arm well-produced, anterior arm meeting so as to form the letter 'b'
 ... *Bruelia uncinosa plana* Ansari (1957) ex *Corvus corone corone* Linn.
26. Mesosomal plate more or less rounded. (Vulva with scarce chaetotaxy)
 *Bruelia elegans* Ansari (1957) ex *Gymnohorina tibicen*.
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Bruelia saliemii Ansari (1957) ex *Corvus splendens splendens* Vieillot.
 Tergal plates rectangular, uniformly sclerotized throughout with circular, colourless stigmal spots *Bruelia saliemii mollii* Ansari (1957) ex *Corvus coronoides macrorhynchus* Wagler.
28. Tergites iii-viii with one post-spiracular seta and 4-5 setae in posterior row on each side
 *Bruelia afzali* Ansari (1957) ex *Corvus cryptoleucus* Couch.
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 Proximal head of the paramere with well developed but brief hilt
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31. Preantennal index 1 : 2.04
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- ... *Bruelia leucocephalus* (Nitzsch, 1806) ex *Corvus albicollis* Latham.
 Tergal plates iii-v with 2+3+3+2, vi-vii with 2+2+2+2, ix with
 1+8+8+1 setae; preantennal index 1 : 2.22 ...
 ... *Bruelia theresae* Ansari (1957) ex *Corvus rhipidurus* Hartert.

UNIDENTIFIABLE SPECIES

The females of the closely related species are generally indistinguishable from each other. The specific names which, upto now, are based on female specimens, therefore, cannot be accurately assigned the proper status. These names are given below with a view that those workers who are at present residing in the type-locality of the host of the species involved and have opportunities of obtaining material, may make a collection and help in reducing the confusion.

<i>Bruelia</i> species	Type host (Locality)
1. <i>Bruelia bipunctata</i> (Rudow, 1870)	<i>Corvus albus</i> Muller ; Sudan.
2. <i>B. hamatofasciata</i> (Piaget, 1890)	Probably <i>Pica</i> species.
3. <i>B. latifasciata</i> (Piaget, 1880)	<i>Corvus enca enca</i> (Horsfield) : Germany.
4. <i>B. olivacea</i> (Burmeister, 1831)	<i>Nucifraga c. caryocatactes</i> ; Germany.
5. <i>B. rotundata</i> (Osborn, 1896)	<i>Corvus corone brachyrhynchus</i> Brehm California and Kansas.

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